TECHNICAL SPECIFICATIONS

WASTEWATER TREATMENT PLANT AND OUTFALL IMPROVEMENTS

BRIDGEPORT UTILITIES
BRIDGEPORT, ALABAMA

ISSUED FOR BID

Prepared by:
Black & Veatch Corporation
Atlanta, Georgia

BLACK & VEATCH

B&V Project No. 422372

September 2026

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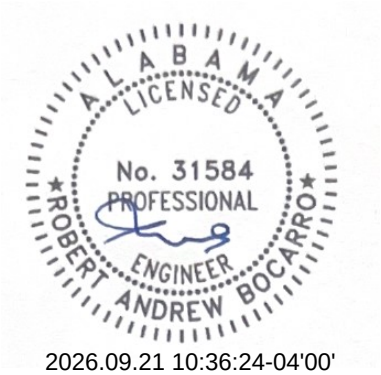
Robert Andrew Bocarro, P.E., No. 31584



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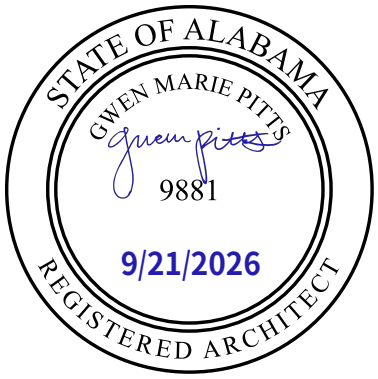

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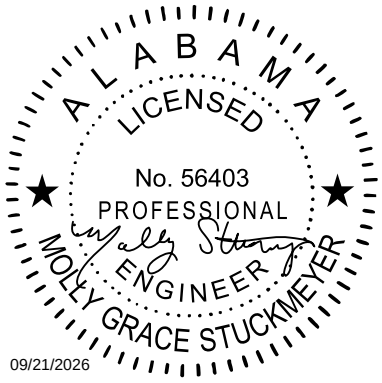

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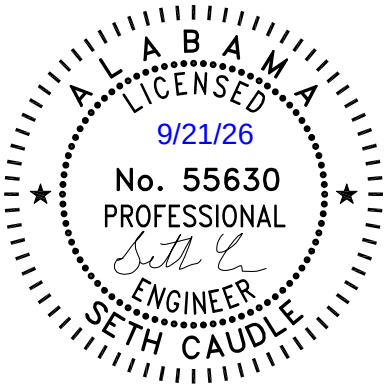

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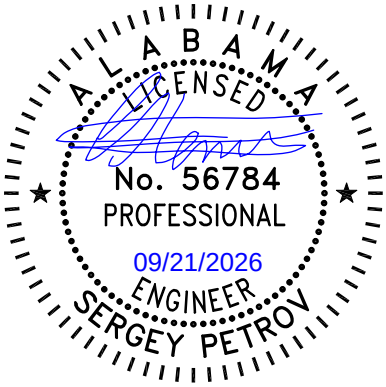

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Section 00 11 16 – Advertisement for Bids

ADVERTISEMENT FOR BIDS
BRIDGEPORT UTILITIES
BRIDGEPORT, ALABAMA
WASTEWATER TREATMENT & OUTFALL IMPROVEMENTS

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General Notice

Bridgeport Utilities (Owner) is requesting Bids for the construction of the following Project:

Wastewater Treatment & Outfall Improvements
BV Project No. 422372

Bids for the construction of the Project will be received at the **Bridgeport Utilities Board** located at **513 Alabama Ave., PO Box 36, Bridgeport, AL 35740**, until **10:00 am on Thursday, October 29, 2026** local time. At that time the Bids received will be **publicly** opened and read.

The Project includes the following Work:

1) Existing Lagoon Upgrade:
    - Demolition of existing high speed surface aerators in Influent and Polishing Ponds
    - Three New Floating Brush Aerators to the Influent Pond
    - Two New Floating Brush Aerators to the Polishing Pond
    - New Polishing Pond overflow spillway
2) New Installation for the existing Wastewater Treatment Plant:
    - One Chlorine Contact Basin
    - One Chemical Building
    - One prefabricated structure containing Widows Creek Cooling Water backpressure valve, sulfuric acid injection assembly, and water quality monitoring instrumentation.
3) New Installation for the Effluent Outfall:
    - 24-inch Effluent Sewer Line
    - New river discharge to Tennessee River
4) Widows Creek Cooling Water Pump Station Upgrade
    - Install of two new vertical turbine pumps in existing wetwells
    - Replacement of existing flow meter
    - Associated electrical and HVAC modifications
5) All associated civil/sitework, piping, chemical feed, building mechanical, structural, electrical, and instrumentation work for the completion of the project.

Obtaining the Bidding Documents

The Issuing Office for the Bidding Documents is:

Black & Veatch Corporation , 3 Ravinia Dr NE, Suite 1725, Atlanta, GA 30346. Partial sets of Bidding Documents will not be available from the Issuing Office. Neither Owner or Engineer will be responsible for full or partial sets of Bidding Documents, including addenda, if any, obtained from sources other than the Issuing Office.

Complete sets of Bidding Documents and the Geotechnical Report may be obtained from Black & Veatch Corporation, 3 Ravinia Drive NE, Suite 1725, Atlanta, Georgia 30346, by emailing BarnesG@bv.com, upon receipt of a non-refundable payment of $500.00. Prospective Bidders shall register as Plan Holders with the Issuing Office by providing the bidder's company name, contact person, mailing address, telephone number, and email address. Only firms registered as Plan Holders with the Issuing Office will be provided addenda and other official communications regarding the Project.

Addenda will be transmitted to registered Plan Holders by email or SharePoint site. It is the responsibility of each Plan Holder to maintain current contact information with the Issuing Office and to ensure receipt of all addenda issued for the Project.

Bids submitted by firms that are not registered Plan Holders may be considered non-responsive.

Pre-bid Conference

A mandatory pre-bid conference for the Project will be held on **10:00 am on Tuesday, October 6, 2026** at **Bridge Port Utilities Board** located at **513 Alabama Ave., Bridgeport, AL 35740.** Representatives of Owner Engineer will be present to discuss the Project. Bids will not be accepted from Bidders that do not attend the mandatory pre-bid conference. In response to questions arising at the conference, Engineer will issue Addenda as Engineer considers necessary. Minutes of the meeting will be distributed as part of an Addendum. A site visit will be arranged as needed.

Bidders are responsible for legibly signing the attendance list and for making sure their names appear on the attendance list which will be attached to the minutes of the pre-Bid conference. **Bids from Bidders not listed will not be opened.**

Instructions to Bidders.

Bidders are also encouraged to visit the WWTP Improvements site to get familiar with the sites. The deadline for questions is **Tuesday, October 13, 2026 at 4:00 pm**.

The time allowed for Substantial Completion is 550 days, and the time allowed for Final Completion and readiness for final payment is 580 days from the date of commencement.

Each Bid must be accompanied by a Bid Bond with good and sufficient surety or sureties approved by the OWNER for faithful acceptance of the contract, payable to, in favor of, and for the protection of the OWNER in an amount equivalent to five percent (5%) of the total amount payable by the terms of the contract or, in lieu thereof, a certified check, cashier's check, or cash in equal amount.

The successful bidder will be required to furnish the necessary additional Bond(s) as described in the Bidding Documents.

Each Bid must be accompanied by a valid Alabama General Contractor license.

The Bidder shall submit an EMR rate with the Bid.

The Bidder shall submit a completed Proposed Subcontractor Form (Section 00 43 36) with its Bid, identifying the major subcontractors proposed for use on the Project.

To demonstrate Bidder's qualifications to perform the Work, after submitting its Bid and within **five (5)** days after the bid opening, Bidder must submit the following information:

A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.
B. Evidence of compliance with the requirements of the Code of Alabama, Title 34, Chapter 8, and the rules and regulations of the Alabama Licensing Board for General Contractors.
C. Other required information regarding qualifications.

All Bids will remain subject to acceptance for 60 days after the day of the Bid opening, but OWNER may, in its sole discretion, release any Bid and return the Bid security prior to that date.

The Owner reserves the right to reject any or all Bids, to waive informalities and re-advertise.

End of Section

INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION CONTRACT

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ARTICLE 1—DEFINED TERMS

1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

A. *Issuing Office*—The office from which the Bidding Documents are to be issued, and which registers plan holders.

ARTICLE 2—BIDDING DOCUMENTS

2.01 Issuing Office

A. The Issuing Office for the Bidding Documents is identified in the Advertisement for Bids:

2.02 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding Documents). See the Agreement for a list of the Contract Documents. It is Bidder's responsibility to determine that it is using a complete set of documents in the preparation of a Bid. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete documents, by Bidder itself or by its prospective Subcontractors and Suppliers.

2.03 Bidding Documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download or distribution of the Bidding Documents does not confer a license or grant permission or authorization for any other use. Authorization to download documents, or other distribution, includes the right for plan holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the plan holder pays all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.

2.04 *Electronic Documents*

A. When the Bidding Requirements indicate that electronic (digital) copies of the Bidding Documents are available, such documents will be made available to the Bidders as Electronic Documents in the manner specified.

1. Bidding Documents will be provided in PDF (Portable Document Format) (.pdf). It is the intent of the Engineer and Owner that such Electronic Documents are to be exactly representative of the paper copies of the documents. However, because the Owner and Engineer cannot totally control the transmission and receipt of Electronic Documents nor the Contractor's means of reproduction of such documents, the Owner and Engineer cannot and do not guarantee that Electronic Documents and reproductions prepared from those versions are identical in every manner to the paper copies.

B. Unless otherwise stated in the Bidding Documents, the Bidder may use and rely upon complete sets of Electronic Documents of the Bidding Documents, described in Paragraph 2.04.A above. However, Bidder assumes all risks associated with differences arising from transmission/receipt of Electronic Documents versions of Bidding Documents and reproductions prepared from those versions and, further, assumes all risks, costs, and responsibility associated with use of the Electronic Documents versions to derive information that is not explicitly contained in printed paper versions of the documents, and for Bidder's reliance upon such derived information.

ARTICLE 3—QUALIFICATIONS OF BIDDERS

3.01 Owner reserves the right to reject any Bidder who does not satisfy the Owner as to its ability to successfully perform the Work.

3.02 The Owner reserves the right to waive any informality, irregularity, or minor defect in any Bid and to accept the Bid that, in the Owner's judgment.

3.03 To demonstrate Bidder's qualifications to perform the Work, after submitting its Bid and within **five (5)** days after the bid opening, Bidder must submit the following information:

A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.

B. Evidence of compliance with the requirements of the Code of Alabama, Title 34, Chapter 8, and the rules and regulations of the Alabama Licensing Board for General Contractors.

C. Other required information regarding qualifications.

3.04 Failure of Bidder to provide such information, within **ten (10)** days of notification of request, shall be grounds for forfeiting of the bid security of that Bidder.

ARTICLE 4—PRE-BID CONFERENCE

4.01 A mandatory pre-bid conference will be held at the time and location indicated in the Advertisement or invitation to bid. Representatives of Owner and Engineer will be present to discuss the Project. Bids will not be accepted from Bidders who do not attend the conference. It is each Bidder's responsibility to sign in at the pre-bid conference to verify its participation. Bidders must sign in using the name of the organization that will be submitting a Bid. A list of qualified Bidders that attended the pre-bid conference and are eligible to submit a Bid for this Project will be issued in an Addendum.

4.02 Information presented at the pre-Bid conference does not alter the Contract Documents. Owner will issue Addenda to make any changes to the Contract Documents that result from discussions at the pre-Bid conference. Information presented, and statements made at the pre-bid conference will not be binding or legally effective unless incorporated in an Addendum.

ARTICLE 5—SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

5.01 *Site and Other Areas*

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

5.02 *Existing Site Conditions*

A. *Subsurface and Physical Conditions; Hazardous Environmental Conditions*

1. The Supplementary Conditions identify the following regarding existing conditions at or adjacent to the Site:

a. Those reports, if any, of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.

b. Those drawings, if any, known to Owner of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data.

c. Reports and drawings, if any, known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner or Engineer.
d. Technical Data contained in such reports and drawings.

2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.
3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.
4. *Geotechnical Baseline Report/Geotechnical Data Report:* The Bidding Documents contain a Geotechnical Baseline Report (GBR) and Geotechnical Data Report (GDR).
   a. As set forth in the Supplementary Conditions, the GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations ("Baseline Conditions"). The GBR is a Contract Document.
   b. The Baseline Conditions in the GBR are intended to reduce uncertainty and the degree of contingency in submitted Bids. However, Bidders cannot rely solely on the Baseline Conditions. Bids should be based on a comprehensive approach that includes an independent review and analysis of the GBR, all other Contract Documents, Technical Data, other available information, and observable surface conditions. Not all potential subsurface conditions are baselined.
   c. Nothing in the GBR is intended to relieve Bidders of the responsibility to make their own determinations regarding construction costs, bidding strategies, and Bid prices, nor of the responsibility to select and be responsible for the means, methods, techniques, sequences, and procedures of construction, and for safety precautions and programs incident thereto.
   d. As set forth in the Supplementary Conditions, the GDR is a Contract Document containing data prepared by or for the Owner in support of the GBR.

B. *Underground Facilities:* Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05 of the General Conditions, and not in the drawings referred to in Paragraph 5.02.A of these Instructions to Bidders. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

5.03 *Site Visit and Testing by Bidders*

A. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder general access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site. Bidder is responsible for establishing access needed to reach specific selected test sites.

B. Bidder must comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

C. Bidder must fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

5.04 *Other Work at the Site*

A. Reference is made to General Requirements, Division 01 for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

5.05 It is the responsibility of each Bidder before submitting a Bid to:

A. Examine and carefully study the Bidding Documents, and the other related data identified in the Bidding Documents;

B. Visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

C. Become familiar with and satisfy Bidder as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work;

D. Carefully study all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) that have been identified in Paragraph 4.02 of the Supplementary Conditions as containing reliable "technical data," and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in the Paragraph 4.06 of the Supplementary Conditions as containing reliable "technical data";

E. Consider 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 any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder’s safety precautions and programs;

F. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its 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. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and

I. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.

5.06 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 5, that without exception the Bid is premised

upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Express Representations and Certifications in Bid Form, Agreement*

A. The Bid Form that each Bidder will submit contains express representations regarding the Bidder's examination of Project documentation, Site visit, and preparation of the Bid, and certifications regarding lack of collusion or fraud in connection with the Bid. Bidder should review these representations and certifications, and assure that Bidder can make the representations and certifications in good faith, before executing and submitting its Bid.

B. If Bidder is awarded the Contract, Bidder (as Contractor) will make similar express representations and certifications when it executes the Agreement.

ARTICLE 7—INTERPRETATIONS AND ADDENDA

7.01 Owner on its own initiative may issue Addenda to clarify, correct, supplement, or change the Bidding Documents.

7.02 Bidder shall submit all questions about the meaning or intent of the Bidding Documents to Engineer in writing. Contact information and submittal procedures for such questions are as follows:

A. **All question shall be submitted to Gillian Barnes at BarnesG@bv.com.**

7.03 Interpretations or clarifications considered necessary by Owner and Engineer in response to such questions will be issued by Addenda delivered to all registered plan holders. Questions received less than **seven (7)** days prior to the date for opening of Bids may not be answered.

7.04 Only responses set forth in an Addendum will be binding. Oral and other interpretations or clarifications will be without legal effect. Responses to questions are not part of the Contract Documents unless set forth in an Addendum that expressly modifies or supplements the Contract Documents.

7.05 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

ARTICLE 8—BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a Bid bond issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions. Such Bid bond will be issued in the form included in the Bidding Documents.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract and furnish the required Contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the

case of a penal sum bid bond, and to the extent of Owner's damages in the case of a damages-form bond. Such forfeiture will be Owner's exclusive remedy if Bidder defaults.

8.03 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

ARTICLE 9—CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be (a) substantially completed and (b) ready for final payment, and (c) Milestones (if any) are to be achieved, are set forth in the Agreement.

9.02 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 10—SUBSTITUTE AND "OR EQUAL" ITEMS

10.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or "or-equal" items. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or "or-equal" item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

10.02 All prices that Bidder sets forth in its Bid will be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of "or-equal" or substitution requests are made at Bidder's sole risk.

ARTICLE 11—SUBCONTRACTORS, SUPPLIERS, AND OTHERS

11.01 A Bidder must be prepared to retain specific Subcontractors and Suppliers for the performance of the Work if required to do so by the Bidding Documents or in the Specifications. If a prospective Bidder objects to retaining any such Subcontractor or Supplier and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

11.02 Bidder shall submit a completed Proposed Major Equipment and Subcontractor Form (Section 00 43 36) with its Bid, identifying the major subcontractors proposed for use on the Project.

11.03 If requested by Owner, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor or Supplier. If Owner, or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor or Supplier, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder will submit a substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.

11.04 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors and Suppliers. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security

of any Bidder. Any Subcontractor or Supplier, so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.

ARTICLE 12—PREPARATION OF BID

12.01 The Bid Form is included with the Bidding Documents.

A. All blanks on the Bid Form must be completed in ink and the Bid Form signed in ink. Erasures or alterations must be initialed in ink by the person signing the Bid Form. A Bid price must be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."

12.02 If Bidder has obtained the Bidding Documents as Electronic Documents, then Bidder shall prepare its Bid on a paper copy of the Bid Form printed from the Electronic Documents version of the Bidding Documents. The printed copy of the Bid Form must be clearly legible, printed on 8-½-inch by 11-inch paper and as closely identical in appearance to the Electronic Document version of the Bid Form as may be practical. The Owner reserves the right to accept Bid Forms which nominally vary in appearance from the original paper version of the Bid Form, providing that all required information and submittals are included with the Bid.

12.03 A Bid by a corporation must be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown.

12.04 A Bid by a partnership must be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership must be shown.

12.05 A Bid by a limited liability company must be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.

12.06 A Bid by an individual must show the Bidder's name and official address.

12.07 A Bid by a joint venture must be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The joint venture must have been formally established prior to submittal of a Bid, and the official address of the joint venture must be shown.

12.08 All names must be printed in ink below the signatures.

12.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.

12.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be shown.

12.11 The Bid must contain evidence of Bidder's authority to do business in the state where the Project is located, or Bidder must certify in writing that it will obtain such authority within the time for acceptance of Bids and attach such certification to the Bid.

ARTICLE 13—BASIS OF BID

13.01 *Lump Sum*

A. Bidders must submit a Bid on a lump sum basis as set forth in the Bid Form.

13.02 *Allowances*

A. For cash allowances the Bid price must include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 13.02.B of the General Conditions.

B. The contingency allowance(s) and cash allowance(s) indicated in the Bid Form shall be included in the total bid.

ARTICLE 14—SUBMITTAL OF BID

14.01 The Bidding Documents include one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 2 of the Bid Form.

14.02 A Bid must be received no later than the date and time prescribed and at the place indicated in the Advertisement or invitation to bid, or at the modified time and place indicated by Addendum, and must be enclosed in a plainly marked package with the Project title, and, if applicable, the designated portion of the Project for which the Bid is submitted, the name and address of Bidder, and must be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid must be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid must be addressed to the location designated in the Advertisement.

14.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

ARTICLE 15—MODIFICATION AND WITHDRAWAL OF BID

15.01 An unopened Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

15.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 15.01 and submit a new Bid prior to the date and time for the opening of Bids.

15.03 If within 24 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 material and substantial mistake in the preparation of its Bid, the Bidder may withdraw its Bid, and

the Bid security will be returned. Thereafter, if the Work is rebid, the Bidder will be disqualified from further bidding on the Work.

ARTICLE 16—OPENING OF BIDS

16.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 17—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 18—EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner also reserves the right to waive all minor Bid informalities not involving price, time, or changes in the Work.

18.02 Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible.

18.03 If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, whether in the Bid itself or in a separate communication to Owner or Engineer, then Owner will reject the Bid as nonresponsive.

18.04 If Owner awards the contract for the Work, such award will be to the responsible Bidder submitting the lowest responsive Bid.

18.05 *Evaluation of Bids*

A. In evaluating Bids, Owner will consider whether 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.

B. In the comparison of Bids, alternates will be applied in the same order of priority as listed in the Bid Form. To determine the Bid prices for purposes of comparison, Owner will announce to all bidders a "Base Bid plus alternates" budget after receiving all Bids, but prior to opening them. For comparison purposes alternates will be accepted, following the order of priority established in the Bid Form, until doing so would cause the budget to be exceeded. After determination of the Successful Bidder based on this comparative process and on the responsiveness, responsibility, and other factors set forth in these Instructions, the award may be made to said Successful Bidder on its base Bid and any combination of its additive alternate Bids for which Owner determines funds will be available at the time of award.

C. For determination of the apparent low Bidder(s) when sectional bids are submitted, Bids will be compared on the basis of the aggregate of the Bids for separate sections and the Bids for combined sections that result in the lowest total amount for all of the Work.

D. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.

18.06 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for

those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

18.07 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

ARTICLE 19—BONDS AND INSURANCE

19.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by required bonds and insurance documentation.

19.02 Article 8, Bid Security, of these Instructions, addresses any requirements for providing bid bonds as part of the bidding process.

ARTICLE 20—SIGNING OF AGREEMENT

20.01 Specifier. The minimum required number of copies of the Agreement is usually four: one each for Owner, Engineer, Contractor, and Surety. This should be verified with the Owner on each project, to determine whether additional copies are needed. Instructions as to procedures and distribution of copies may be modified accordingly. Coordinate copy distribution with the Agreement.

20.02 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by six (6) unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Agreement and any bonds and insurance documentation required to be delivered by the Contract Documents to Owner. Within 10 days thereafter, Owner will deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 21—SALES AND USE TAXES

21.01 The Contractor is responsible for reviewing pertinent state status involving sales tax and complying with the requirements. The Contractor shall pay all applicable sales, consumer, and other taxes as required by law.

End of Section

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Section 00 41 00 – Bid Form

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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.

PROJECT IDENTIFICATION:

Bridgeport Utilities
Wastewater Treatment & Outfall Improvements

ARTICLE 1— OWNER AND BIDDER

1.01 This Bid is submitted to:

Bridgeport Utilities
513 Alabama Ave., PO Box 36,
Bridgeport, AL 35740

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—ATTACHMENTS TO THIS BID

2.01 The following documents are submitted with and made a condition of this Bid:
- A. Required Bid security in the form of a Bid bond as required by the instructions to Bidders;
- B. Contractor's license number as evidence to do business in the state of the Project; or a written covenant by Bidder to obtain said license within the time for acceptance of Bids;
- C. EMR rate.
- D. List of proposed subcontractors by completing Specifications Section 00 43 36 – Proposed Subcontractor Form.
- E. Non-Collusion Affidavit.

ARTICLE 3—BASIS OF BID—LUMP SUM BID AND UNIT PRICES

3.01 *Lump Sum Bids*
- A. Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price(s):
  1. Lump Sum Price (Single Lump Sum)

B. All specified cash allowance(s) are included in the price(s) set forth below, and have been computed in accordance with Paragraph 13.02 of the General Conditions.

C. All specified contingency allowances are included in the price(s) set forth below, and have been computed in accordance with Paragraph 13.02 of the General Conditions.

D. All bid items shall include all costs for furnishing all labor, materials, equipment, supplies, allowances and all other costs including permit fees, taxes, insurance, miscellaneous costs, overhead and profit incurred for the work, complete in place. Payment shall be in accordance with the General Conditions. Any unused balance of the unit price items shall revert to the Owner upon completion of the project.

E. The Bid Form is structured to obtain pricing for multiple acceptable equipment manufacturers for each major equipment category. The Subtotal Equipment Price "A" will be the total of the lowest-priced equipment manufacturer for each equipment category. The Total Bid Price shall be the sum of Subtotal Equipment Price "A" and Subtotal Price "B". The Owner reserves the right to waive any informality, irregularity, or minor defect in any Bid and to accept the Bid that, in the Owner's judgment to provide the most economical project. Following award of the Contract, the Owner reserves the right to select any manufacturer included in the Bid Form. If the manufacturer selected by the Owner differs from the lowest-priced manufacturer, the Contract Price shall be adjusted by Change Order based on the pricing submitted in the Bid Form for the selected manufacturer:

I	II	III	IV	V
Item No.	**Proposed Work**	**Specifications Section**	**Accepted Equipment** (Note 4)	**Cost for Each Equipment manufacturer Alternative** (Note 1 and 2)
1	High Service Pump Station (Vertical Diffusion Vane Pumps)	43 24 13	1. Sulzer (Price Required) **OR** 2. Xylem/Goulds (Price Required) **OR** 3. Patterson **OR** 4. Alternative 1 _____	1. $_____ 2. $_____ 3. $_____ 4. $_____
2	Large Chemical Metering Skids (Bisulfite, Hypochlorite, Sulfuric Acid)	46 33 00	1. Milton Roy **OR** 2. Pulsafeeder **OR** 3. Prominent **OR** 4. Alternative 1 _____	1. $_____ 2. $_____ 3. $_____ 4. $_____

I	II	III	IV	V
Item No.	**Proposed Work**	**Specifications Section**	**Accepted Equipment** (Note 4)	**Cost for Each Equipment manufacturer Alternative** (Note 1 and 2)
3	600 Volt Class Motor Control Centers	26 24 23	1. ABB **OR** 2. Allen Bradley **OR** 3. Eaton **OR** 4. Schneider-Electric **OR** 5. Siemens	1. $_____ 2. $_____ 3. $_____ 4. $_____ 5. $_____
4	Adjustable Frequency Drives	26 29 24	1. ABB **OR** 2. Eaton **OR** 3. Rockwell Automation **OR** 4. Schneider-Electric **OR** 5. Toshiba	1. $_____ 2. $_____ 3. $_____ 4. $_____ 5. $_____
5	Engine-Generators	26 32 13	1. Caterpillar **OR** 2. Cummins **OR** 3. Rolls-Royce/MTU **OR** 4. Rehlko/Kohler	1. $_____ 2. $_____ 3. $_____ 4. $_____
6	Floating Brush Aerators	46 51 13	1. House Industries (Note 3)	1. $_____
Subtotal Equipment Price "A" (Item 1 - 6) (Note 5)				$_____

Item No.	Description	Unit	Estimated Quantity	Bid Unit Price	Bid Amount
7	Wastewater Treatment & Outfall Improvements (Note 6)	LS	1	$_____	$_____
8	Owner Cash Allowance	LS	1	-	$ 500,000.00
9	Owner Contingency Allowance	LS	1	-	$ 2,500,000.00
Subtotal Price "B" (Item 7 - 9)					$_____
Total Bid Price "A" + "B" (Item 1 - 9)					**$**_____

Notes:

1. Pricing for each equipment manufacturer shall include all labor, materials, installation, equipment, supplies, permit fees, taxes, insurance, overhead, profit, and all other costs necessary to complete the work for the proposed work under column II.
2. Bidders shall provide pricing for both Sulzer and Xylem/Goulds equipment for the High Service Pump Station. Pricing for these manufacturers is mandatory regardless of which manufacturer results in the lowest bid price.
3. Bidders shall provide pricing for the Floating Brush Aerators based on the House Industries equipment quote in the amount of $243,500 included in Specification Section 46 51 13. Pricing shall include all costs necessary to furnish and install a complete and operational Floating Brush Aerator system. No manufacturers other than House Industries will be considered for this Work item.
4. Bidders may propose additional manufacturer alternatives by entering the manufacturer name in the space provided in Column IV. Equipment Alternative Bid prices shall include the entire cost of the Alternative, including cost for engineering changes to accommodate the Alternative, and additional work to be performed which is not shown on the Drawings, but which is required as a result of selection of the Alternative. Refer to the “Or-Equal” clause in Article 10 of Specifications Section 00 21 13 – Instructions to Bidders, and the applicable "Or-Equal" requirements in the equipment specifications identified in Column III.
5. Subtotal Equipment Price “A” shall be calculated as the sum of the lowest-priced equipment manufacturer offered by the Bidder for each equipment category listed in Items 1 through 6. The Bidder shall clearly identify the lowest-priced manufacturer for each equipment category by highlighting, circling, or other clearly distinguishable marking.
6. Item 7 shall include all Work required to complete the Project, including all labor, materials, equipment, supplies, allowances, permit fees, taxes, insurance, miscellaneous expenses, overhead, profit, and incidentals necessary to provide a complete and operational facility. Costs associated with Items 1 through 6 shall not be included in Item 7.

TOTAL BID AMOUNT_____

TOTAL BID AMOUNT IN WORDS_____

_____

ARTICLE 4—TIME OF COMPLETION

4.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

4.02 Bidder agrees that the Work covered by the Milestone or Milestones, if any, indicated in the Agreement will be completed as required by the Contract Documents.

4.03 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 5—BIDDER'S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

5.01 *Bid Acceptance Period*

A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

5.02 *Instructions to Bidders*

A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.

5.03 *Receipt of Addenda*

A. Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Bidder's Representations*

A. In submitting this Bid, Bidder represents the following:

1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.
2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Bidder has considered the information known to Bidder itself; 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 Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder's (Contractor's) safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. 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.

9. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

6.02 *Bidder's Certifications*

A. The Bidder certifies the following:
   1. 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.
   2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
   3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
   4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 8.02.A:
      a. 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.
      b. 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.
      c. 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.
      d. 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.
   5. Bidder has attended the pre-Bid conference.

BIDDER hereby submits this Bid as set forth above:

Bidder:

_____

(typed or printed name of organization)

By: _____

(individual's signature)

Name: _____

(typed or printed)

Title: _____

(typed or printed)

Date: _____

(typed or printed)

If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

Address for giving notices:

_____

_____

Bidder's Contact:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Phone: _____

Email: _____

Address:

_____

_____

_____

Bidder's Contractor License No.: _____

Bidder's Contractor License Expiration Date: _____

This page intentionally left blank.

Section 00 43 14 - Guidance for the Selection of BID BOND – PENAL FORM

BID BOND (PENAL SUM FORM)

Bidder Name: Address *(principal place of business)*:	**Surety** Name: Address *(principal place of business)*:
Owner Name: **Bridgeport Utilities** Address *(principal place of business)*: **513 Alabama Ave., PO Box 36, Bridgeport, AL 35740**	**Bid** Project *(name and location)*: **WWTP & Outfall Improvements** Bid Due Date: **October 29, 2026**
Bond Penal Sum: Date of Bond:	
Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth in this Bid Bond, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.	
Bidder _____ *(Full formal name of Bidder)* By: _____ *(Signature)* Name: _____ *(Printed or typed)* Title: _____ Attest: _____ *(Signature)* Name: _____ *(Printed or typed)* Title:	Surety _____ *(Full formal name of Surety) (corporate seal)* By: _____ *(Signature) (Attach Power of Attorney)* Name: _____ *(Printed or typed)* Title: _____ Attest: _____ *(Signature)* Name: _____ *(Printed or typed)* Title:
Notes: (1) Note: Addresses are to be used for giving any required notice. (2) Provide execution by any additional parties, such as joint venturers, if necessary.	

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond will be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder occurs upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation will be null and void if:
   3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
   3.2. All Bids are rejected by Owner, or
   3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions does not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond will be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder must be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Postal Service registered or certified mail, return receipt requested, postage pre-paid, and will be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond will be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute governs and the remainder of this Bond that is not in conflict therewith continues in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

SECTION 00 43 36 - PROPOSED SUBCONTRACTORS FORM

In compliance with the Instructions to Bidders and other Contract Documents, the undersigned submits the following names of Subcontractors to be used in performing the Work for_____.

Bidder certifies that all Subcontractors listed are eligible to perform the Work.

Subcontractor's Work	Subcontractor's Name
Excavation	_____
Concrete	_____
Painting	_____
Masonry	_____
Mechanical	_____
Electrical	_____
Instrumentation	_____
Plumbing	_____

_____	_____
_____	_____

NOTE: This form must be submitted with the Bid.

_____

Bidder's Signature

NON-COLLUSION AFFIDAVIT

City: _____

County: _____

State: _____

_____ being first duly sworn, deposes and says that
Authorized Officer

he/she is _____ of _____
(Owner, Partner, President, etc.) Company Name

the party making the foregoing proposal or bid; that such bid is genuine and not collusive or sham; that said bidder has not colluded, conspired, connived, or agreed, directly or indirectly, with any bidder or person, to put in a sham bid, or that such other person shall refrain from bidding, and has not in any manner, directly or indirectly sought by agreement or collusion, communication or conference, with any person, to fix the bid price of affiant or another 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 Owner or any person or persons interested in the proposed contract; and that all statements contained in said proposal or bid are true; further, that such bidder has not, directly or indirectly submitted this bid, or that contents thereof, or divulged information or data relative thereto any association or to any member of agent thereof.

_____
Affiant

Sworn and subscribed before me this _____ day of _____, 202__.

_____
Notary Public

County: _____

State: _____

(SEAL)

_____
Expiration Date

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Section 00 51 00 - Notice of Award

NOTICE OF AWARD

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Date of Issuance: _____

Owner: _____

Owner's Project No.: _____

Engineer: _____

Engineer's Project No.: _____

Project: _____

Contract Name: _____

Bidder: _____

Bidder's Address: _____

You are notified that Owner has accepted your Bid dated _____ for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

WWTP & Outfall Improvements

The Contract Price of the awarded Contract is $_____. Contract Price is subject to adjustment based on the provisions of the Contract, including but not limited to those governing changes and Unit Price Work as applicable.

six (6) unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically.

☐ Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner **six (6)** counterparts of the Contract Documents, signed by Bidder (as Contractor) leaving the Effective Date of the Contract blank.
2. Deliver with the signed Contract Documents the Contract security (such as required performance and payment bonds) and insurance documentation, as specified in the Instructions to Bidders and in the General Conditions, Articles 2 and 6.

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully signed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: **Bridgeport Utilities**
By *(signature)*: _____
Name *(printed)*: _____
Title: _____
Copy: Engineer

Section 00 52 13 - AGREEMENT FORM

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This Agreement is by and between **Bridgeport Utilities** ("Owner") and _____ ("Contractor").

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

Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

1) Existing Lagoon Upgrade:
   - Demolition of existing high speed surface aerators in Influent and Polishing Ponds
   - Three New Floating Brush Aerators to the Influent Pond
   - Two New Floating Brush Aerators to the Polishing Pond
   - New Polishing Pond overflow spillway
2) New Installation for the existing Wastewater Treatment Plant:
   - One Chlorine Contact Basin
   - One Chemical Building
   - One prefabricated structure containing Widows Creek Cooling Water backpressure valve, sulfuric acid injection assembly, and water quality monitoring instrumentation.
3) New Installation for the Effluent Outfall:
   - 20-inch Effluent Sewer Line
   - New river discharge to Tennessee River
4) Widows Creek Cooling Water Pump Station Upgrade
   - Install of two new vertical turbine pumps in existing wetwells
   - Replacement of existing flow meter
   - Installation of new air release valves on existing cooling water pipeline from Cooling Water Pump Station to Wastewater Treatment Plant
   - Associated electrical and HVAC modifications
5) All associated civil/sitework, piping, chemical feed, building mechanical, structural, electrical, and instrumentation work for the completion of the project.

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: **WWTP & Outfall Improvements.**

ARTICLE 3—ENGINEER

3.01 The Owner has retained **Black & Veatch Corporation** ("Engineer") to act as Owner's representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by Engineer**.**

ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Contract Times: Days*

A. The Work will be substantially complete within **550** days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within **580** days after the date when the Contract Times commence to run.

4.04 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner $**500** for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.

2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $**500** for each day that expires after such time until the Work is completed and ready for final payment.

4. Liquidated damages for failing to timely attain Substantial Completion, and final completion are not additive, and will not be imposed concurrently.

B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

ARTICLE 5—CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:

A. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the **25th** day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.

a. **95** percent of the value of the Work completed (with the balance being retainage).

1) If 50 percent or more of the Work has been completed, as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and

b. **95** percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to **100** percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less **200** percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return,

or release. Consent of the Surety, signed by an agent, must be accompanied by a certified copy of such agent's authority to act for the Surety.

6.05 *Interest*

A. All amounts not paid when due will bear interest at the rate listed in Supplementary Conditions.

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

A. The Contract Documents consist of all of the following:

1. This Agreement.
2. Bonds:
   a. Performance bond (together with power of attorney).
   b. Payment bond (together with power of attorney).
3. General Conditions.
4. Supplementary Conditions.
5. Specifications as listed in the table of contents of the project manual (copy of list attached).
6. Drawings (not attached but incorporated by reference) consisting of **124** sheets with each sheet bearing the following general title: **WWTP & Outfall Improvements**. Sheet titles are listed on the cover sheet.
7. Addenda (numbers ___ to ___, inclusive).
9. Exhibits to this Agreement (enumerated as follows):
   a. Contractor's Bid
   b. Documentation submitted by Contractor prior to Notice of Award
   c. Other exhibits or certifications (if applicable) accompanying this Agreement.
10. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.
    d. Field Orders.
    e. Warranty Bond, if any.

B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 7.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

E. In accordance with Instructions to Bidders Article 3.02, to demonstrate Bidder's qualifications to perform the Work, after submitting its Bid and within five (5) days after the bid opening, Bidder must submit the following information:

1. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.
2. Written statement that Bidder is authorized to do business in the state where the Project is located, or a written certification that Bidder will obtain such authority prior to the Effective Date of the Contract.
3. Bidder's state or other contractor license number, if applicable.
4. Subcontractor and Supplier qualification information.
5. Other required information regarding qualifications.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 *Contractor's Representations*

A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:

1. Contractor has examined and carefully studied the Contract Documents, including Addenda.
2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.
7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies,

or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

8. Contractor 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 Contract Documents.

9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:

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 Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract 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.

8.03 *Standard General Conditions*

A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or "track changes" (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

This Agreement will be effective on _____ (which is the Effective Date of the Contract).

Owner:

Bridgeport Utilities
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Bridgeport Utilities Board

513 Alabama Ave., PO Box 36

Bridgeport, AL 35740

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone: _____

Email: _____

Attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)

Contractor:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Date: _____
(date signed)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

*(If **[Type of Entity]** is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*

Attest: _____
(individual's signature)

Title: _____
(typed or printed)

Address for giving notices:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone: _____

Email: _____

License No.: _____
(where applicable)

State: _____

Section 00 55 00 - NOTICE TO PROCEED

NOTICE TO PROCEED

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Owner:	Bridgeport Utilities
Owner's Project No.:	
Engineer:	Black & Veatch Corporation
Engineer's Project No.:	422372
Contractor:	
Contractor's Project No.:	
Project:	WWTP & Outfall Improvements
Contract Name:	
Effective Date of Contract:	

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on _____ pursuant to Paragraph 4.01 of the General Conditions.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.

In accordance with the Agreement:

The number of days to achieve Substantial Completion is **550 days** from the date stated above for the commencement of the Contract Times, resulting in a date for Substantial Completion of _____; and the number of days to achieve readiness for final payment is **580 days** from the commencement date of the Contract Times, resulting in a date for readiness for final payment of _____.

Owner:	**Bridgeport Utilities**
By *(signature)*:	
Name *(printed)*:	
Title:	
Date Issued:	

Copy: Engineer

This page intentionally left blank.

PERFORMANCE BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: **Bridgeport Utilities**	Description *(name and location)*: **WWTP & Outfall Improvements**
Mailing address *(principal place of business)*: **513 Alabama Ave., PO Box 36, Bridgeport, AL 35740**	Contract Price:
	Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

1. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
2. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
   2.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
   2.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
   2.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
3. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
4. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
   4.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
   4.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
   4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
   4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:
      5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
      5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
5. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in

whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.

6. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
   6.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
   6.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
   6.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
7. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
8. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
9. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
10. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the 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 periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
11. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
12. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
13. Definitions
   13.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
   13.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
   13.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
   13.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

13.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

14. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
15. Modifications to this Bond are as follows: None

PAYMENT BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: **Bridgeport Utilities** Mailing address *(principal place of business)*: **513 Alabama Ave., PO Box 36, Bridgeport, AL 35740**	Description *(name and location)*: **WWTP& Outfall Improvements** Contract Price: Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
_____	_____
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____	By: _____
(Signature)	*(Signature)(Attach Power of Attorney)*
Name: _____	Name: _____
(Printed or typed)	*(Printed or typed)*
Title: _____	Title: _____
Attest: _____	Attest: _____
(Signature)	*(Signature)*
Name: _____	Name: _____
(Printed or typed)	*(Printed or typed)*
Title: _____	Title: _____

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
   5.1. Claimants who do not have a direct contract with the Contractor
      5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
      5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
   5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
   7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
   7.2. Pay or arrange for payment of any undisputed amounts.
   7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.
8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to

satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, 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 Construction 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 will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
    - 16.1. *Claim*—A written statement by the Claimant including at a minimum:
        - 16.1.1. The name of the Claimant;
        - 16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;
        - 16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
        - 16.1.4. A brief description of the labor, materials, or equipment furnished;
        - 16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
        - 16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
        - 16.1.7. The total amount of previous payments received by the Claimant; and
        - 16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.
    - 16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction

Contract, architectural and engineering services required for performance of the work of the Contractor and the 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.

16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

18. Modifications to this Bond are as follows: None

FIELD ORDER NO.: [Number of Field Order]

Owner: Owner's Project No.:
Engineer: Engineer's Project No.:
Contractor: Contractor's Project No.:
Project:
Contract Name:
Date Issued: Effective Date of Field Order:

Contractor is hereby directed to promptly perform the Work described in this Field Order, issued in accordance with Paragraph 11.04 of the General Conditions, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference:

Specification Section(s):
Drawing(s) / Details (s):

Description:

Attachments:

Issued by Engineer

By: _____
Title: _____
Date: _____

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Section 00 63 49 - WORK CHANGE DIRECTIVE FORM

INSTRUCTIONS

A. GENERAL INFORMATION

This document was developed for use in situations involving changes in the Work which, if not processed expeditiously, might delay the Project. These changes are often initiated in the field and may affect the Contract Price or the Contract Times. This is not a Change Order, but only a directive to proceed with Work that will likely be included in a subsequent Change Order. Contract Price and Contract Times may only be changed by Change Order signed by Owner and Contractor.

This document is unilateral in nature and does not require Contractor's signature. Owner or Engineer should maintain documentation of the transmittal of a Work Change Directive to Contractor.

For supplemental instructions and minor changes not involving a change in the Contract Price or the Contract Times, a Field Order should be used.

B. COMPLETING THE WORK CHANGE DIRECTIVE FORM

If requested by Owner, Engineer initiates the form, including a description of the items involved and attachments.

Based on conversations among Owner, Engineer and Contractor; Engineer completes the following:

METHOD OF DETERMINING CHANGE, IF ANY, IN CONTRACT PRICE: Mark the method to be used in determining the final cost of Work involved and the estimated net effect on the Contract Price. If the change involves an increase in the Contract Price and the estimated amount is approached before the additional or changed Work is completed, another Work Change Directive must be issued to change the estimated price or Contractor may stop the changed Work when the estimated cost is reached. If the Work Change Directive is not likely to change the Contract Price, the space for estimated increase (decrease) should be marked "Not Applicable".

Once Engineer has completed development of the form, all copies should be sent to Owner for authorization and execution. (Engineer has no authority to authorize changes that may affect Contract Price or Contract Times.) Once authorized by Owner, a copy should be sent to Engineer and to Contractor.

Paragraph 11.02.A.1 of the General Conditions requires that a Change Order be initiated and executed to cover any undisputed sum or amount of time for Work actually performed pursuant to this Work Change Directive.

Once the Work covered by such directive is completed or final cost and times are determined, Contractor should submit documentation for inclusion in a Change Order.

THIS IS A DIRECTIVE TO PROCEED WITH A CHANGE THAT MAY AFFECT THE CONTRACT PRICE OR CONTRACT TIMES. A CHANGE ORDER SHOULD BE CONSIDERED PROMPTLY.

WORK CHANGE DIRECTIVE NO.: [Number of Work Change Directive]

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Owner:	Owner's Project No.:
Engineer:	Engineer's Project No.:
Contractor:	Contractor's Project No.:
Project:	
Contract Name:	
Date Issued:	Effective Date of Work Change Directive:

Contractor is directed to proceed promptly with the following change(s):
Description:

Attachments:

Purpose for the Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:
☐ Non-agreement on pricing of proposed change. ☐ Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price: $ _____ **[increase] [decrease] [not yet estimated]**.

Contract Time: _____ days **[increase] [decrease] [not yet estimated]**.

If the change involves an increase, the estimated change is not to be exceeded without further authorization.

Basis of estimated change in Contract Price:
☐ Lump Sum ☐ Unit Price ☐ Cost of the Work ☐ Other

Authorized by Owner

By: _____

Title: _____

Date: _____

Section 00 63 63 - CHANGE ORDER FORM

INSTRUCTIONS

A. GENERAL INFORMATION

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Contract Price or Contract Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

B. COMPLETING THE CHANGE ORDER FORM

When the subject of a change affects the performance or acceptability of the Work, the design, or other engineering and technical matters, Engineer normally initiates preparation of the form, including preparing a description of the changes involved and attachments based upon review of documents and Change Proposals submitted by Contractor, or requests from Owner, or both.

After Engineer has completed the form, all copies should be sent to Owner for review and approval. Contractor should sign the form and then send to Owner for final execution. Owner should then make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, insert “Zero” or “Not Applicable” to the part of the tabulation that does not apply.

CHANGE ORDER NO.: [Number of Change Order]

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Owner:	Owner's Project No.:
Engineer:	Engineer's Project No.:
Contractor:	Contractor's Project No.:
Project:	
Contract Name:	
Date Issued:	Effective Date of Change Order:

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachments:

Change in Contract Price	Change in Contract Times [State Contract Times as either a specific date or a number of days]
Original Contract Price: $ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] from previously approved Change Orders No. 1 to No. [Number of previous Change Order]: $ _____	[Increase] [Decrease] from previously approved Change Orders No.1 to No. [Number of previous Change Order]: Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: $ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] this Change Order: $ _____	[Increase] [Decrease] this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: $ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

Authorized by Owner

By: _____

Title: _____

Date: _____

Authorized by Contractor	Approved by Funding Agency (if applicable)
By: _____	_____
Title: _____	_____
Date: _____	_____

CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	Bridgeport Utilities	Owner's Project No.:	
Engineer:	Black & Veatch Corporation	Engineer's Project No.:	422372
Contractor:		Contractor's Project No.:	
Project:	WWTP & Outfall Improvements		
Contract Name:			

This ☐ Preliminary ☐ Final Certificate of Substantial Completion applies to:
☐ All Work ☐ The following specified portions of the Work:
[Describe the portion of the work for which Certificate of Substantial Completion is issued]

Date of Substantial Completion: _____

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and 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.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities: ☐ None ☐ As follows:
[List amendments to Owner's Responsibilities]

Amendments to Contractor's Responsibilities: ☐ None ☐ As follows:
[List amendments to Contractor's Responsibilities]

The following documents are attached to and made a part of this Certificate:
[List attachments such as punch list; other documents]

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

EXECUTED BY ENGINEER:	RECEIVED:	RECEIVED:
By: _____ (Authorized signature)	By: _____ Owner (Authorized Signature)	By: _____ Contractor (Authorized Signature)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Section 00 65 19.23 – Notice of Acceptability of Work Form

NOTICE OF ACCEPTABILITY OF WORK

Owner:		Owner's Project No.:	
Engineer:		Engineer's Project No.:	
Contractor:		Contractor's Project No.:	
Project:			
Contract Name:			
Notice Date:		Effective Date of the Construction Contract:	

The Engineer hereby gives notice to the Owner and Contractor that Engineer recommends final payment to Contractor, and that the Work furnished and performed by Contractor under the Construction Contract is acceptable, expressly subject to the provisions of the Construction Contract's Contract Documents ("Contract Documents") and of the Agreement between Owner and Engineer for Professional Services dated _____ ("Owner-Engineer Agreement"). This Notice of Acceptability of Work (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. This Notice has been prepared with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
2. This Notice reflects and is an expression of the Engineer's professional opinion.
3. This Notice has been prepared to the best of Engineer's knowledge, information, and belief as of the Notice Date.
4. This Notice is based entirely on and expressly limited by the scope of services Engineer has been employed by Owner to perform or furnish during construction of the Project (including observation of the Contractor's Work) under the Owner-Engineer Agreement, and applies only to facts that are within Engineer's knowledge or could reasonably have been ascertained by Engineer as a result of carrying out the responsibilities specifically assigned to Engineer under such Owner-Engineer Agreement.
5. This Notice is not a guarantee or warranty of Contractor's performance under the Construction Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Contractor to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.
6. This Notice does not relieve Contractor of any surviving obligations under the Construction Contract, and is subject to Owner's reservations of rights with respect to completion and final payment.

Engineer

By *(signature)*: _____

Name *(printed)*: _____

Title: _____

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION 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

CSI
Building Knowledge
Improving Project Delivery

NUCA
We Dig America

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www.nspe.org

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474
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GUIDELINES FOR USE OF EJCDC® C-700, STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

1.0 PURPOSE AND INTENDED USE OF THE DOCUMENT

EJCDC® C-700, Standard General Conditions of the Construction Contract (2018), is the foundation document for the EJCDC Construction Series. The General Conditions define the basic rights, responsibilities, risk allocations, and contractual relationship of the Owner and Contractor, and establish how the Contract is to be administered.

2.0 OTHER DOCUMENTS

EJCDC documents are intended to be used as a system and changes in one EJCDC document may require a corresponding change in other documents. Other EJCDC documents may also serve as a reference to provide insight or guidance for the preparation of this document.

These General Conditions have been prepared for use with either EJCDC® C-520, Agreement Between Owner and Contractor for Construction Contract (Stipulated Price), or EJCDC® C-525, Agreement Between Owner and Contractor for Construction Contract (Cost-Plus-Fee) (2018 Editions). The provisions of the General Conditions and the Agreement are interrelated, and a change in one may necessitate a change in the other.

To prepare supplementary conditions that are coordinated with the General Conditions, use EJCDC® C-800, Supplementary Conditions of the Construction Contract (2018).

The full EJCDC Construction series of documents is discussed in the EJCDC® C-001, Commentary on the 2018 EJCDC Construction Documents (2018).

3.0 ORGANIZATION OF INFORMATION

All parties involved in a construction project benefit significantly from a standardized approach in the location of subject matter throughout the documents. Experience confirms the danger of addressing the same subject matter in more than one location; doing so frequently leads to confusion and unanticipated legal consequences. Careful attention should be given to the guidance provided in EJCDC® N-122/AIA® A521, Uniform Location of Subject Matter (2012 Edition) when preparing documents. EJCDC® N-122/AIA® A521 is available at no charge from the EJCDC website, www.ejcdc.org, and from the websites of EJCDC's sponsoring organizations.

If CSI MasterFormat™ is used for organizing the Project Manual, consult CSI MasterFormat™ for the appropriate document number (e.g., under 00 11 00, Advertisements and Invitations), and accordingly number the document and its pages.

4.0 EDITING THIS DOCUMENT

Remove these Guidelines for Use. Some users may also prefer to remove the two cover pages.

Although it is permissible to revise the Standard EJCDC Text of C-700 (the content beginning at page 1 and continuing to the end), it is common practice to leave the Standard EJCDC Text of C-700 intact and unaltered, with modifications and supplementation of C-700's provisions set forth in EJCDC® C-800, Supplementary Conditions of the Construction Contract (2018). If the Standard Text itself is revised, the user must comply with the terms of the License Agreement, Paragraph 4.0, Document-Specific Provisions,

concerning the tracking or highlighting of revisions. The following is a summary of the relevant License Agreement provisions:

1. The term "Standard EJCDC Text" for C-700 refers to all text prepared by EJCDC in the main body of the document. Document covers, logos, footers, instructions, or copyright notices are not Standard EJCDC Text for this purpose.
2. During the drafting or negotiating process for C-700, it is important that the two contracting parties are both aware of any changes that have been made to the Standard EJCDC Text. Thus, if a draft or version of C-700 purports to be or appears to be an EJCDC document, the user must plainly show all changes to the Standard EJCDC Text, using "Track Changes" (redline/strikeout), highlighting, or other means of clearly indicating additions and deletions.
3. If C-700 has been revised or altered and is subsequently presented to third parties (such as potential bidders, grant agencies, lenders, or sureties) as an EJCDC document, then the changes to the Standard EJCDC Text must be shown, or the third parties must receive access to a version that shows the changes.
4. Once the document is ready to be finalized (and if applicable executed by the contracting parties), it is no longer necessary to continue to show changes to the Standard EJCDC Text. The user may produce a final version of the document in a format in which all changes are accepted, and the document at that point does not need to include any "Track Changes," redline/strikeout, highlighting, or other indication of additions and deletions to the Standard EJCDC Text.

5.0 LICENSE AGREEMENT

This document is subject to the terms and conditions of the **License Agreement, 2018 EJCDC® Construction Series Documents**. A copy of the License Agreement was furnished at the time of purchase of this document, and is available for review at www.ejcdc.org and the websites of EJCDC's sponsoring organizations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. 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, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
5. *Bidder*—An individual or entity that submits a Bid to Owner.
6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
8. *Change Order*—A document 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, or other revision to the Contract, issued on or after the Effective Date of the Contract.
9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
10. *Claim*
    a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.
    b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision

regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.

d. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.
13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
17. *Cost of the Work*—See Paragraph 13.01 for definition.
18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
20. *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.
21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this 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.
22. *Engineer*—The individual or entity named as such in the Agreement.
23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
    a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained

pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.

b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

25. *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.
26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
29. *Notice to Proceed*—A written notice 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.
30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.
36. *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.
37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
38. *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, and such other lands or areas furnished by Owner which are designated for the use of Contractor.

39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *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.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor 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; Owner-delegated designs; 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; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *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 of such Work.
43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, 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 a Subcontractor.
46. *Technical Data*
    a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.
    b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
    c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
48. *Unit Price Work*—Work to be paid for on the basis of unit prices.
49. *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; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: 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 Article 10 or any other provision of the Contract Documents.

C. *Day*: The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:
   1. does not conform to the Contract Documents;
   2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
   3. 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 15.03 or Paragraph 15.04).

E. *Furnish, Install, Perform, Provide*
   1. The word "furnish," when used in connection with services, materials, or equipment, means 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, means 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, means to furnish and install said services, materials, or equipment complete and ready for intended use.
   4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

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

G. 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 Performance and Payment Bonds; Evidence of Insurance*

A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).

B. *Evidence of Contractor's Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.

C. *Evidence of Owner's Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

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

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), 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;
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.

2.04 *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 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, 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 and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *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 the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will 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 the component parts of the Work.
4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

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

B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor 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.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one Contract Document 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.

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

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

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

F. Any provision or part of the 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 Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

G. Nothing in the Contract Documents creates:

1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract 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, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer 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 part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field

measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents*: If, before or 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) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) 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 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
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 part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
   a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); 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 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers 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 versions, or 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; or
   2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

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

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract 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 Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *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.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 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 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
   2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, 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 Contract Price or Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor'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 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. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
   4. Acts of war or terrorism.

D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
   1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
   2. Contractor shall not be entitled to an adjustment in 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 Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
   3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.

E. Each Contractor request or Change Proposal seeking an increase in Contract Times or 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 the progress of the Work;
   3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
   4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
   5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

   Contractor shall also furnish such additional supporting documentation as Owner 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 of the Work.

F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.
G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor in writing 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.
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 permanent improvements are to be made 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.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*
1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, 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 any such claim, and against all 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 directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will 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 and adjacent areas 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 of 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 structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;
2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and
3. Technical Data contained in such reports and drawings.

B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

D. *Limitations of Other Data and Documents*: Except for such reliance on 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;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
2. is of such a nature as to require a change in the Drawings or Specifications;
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 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

E. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, 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 fall within any one or more of the categories described in Paragraph 5.04.A;
   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 Paragraph 13.03; and,
   c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
   a. Contractor knew of the existence of such condition at the time Contractor made a 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 otherwise;
   b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
   c. Contractor failed to give the written notice required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:
   1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
   2. complying with applicable state and local utility damage prevention Laws and Regulations;
   3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
   4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
   5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then 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 7.15), notify Owner and Engineer in writing regarding such Underground Facility.

C. *Engineer's Review*: Engineer will:
   1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;

2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

F. *Possible Price and Times Adjustments*
   1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
      a. 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 Paragraph 13.03;
      b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
      c. Contractor gave the notice required in Paragraph 5.05.B.
   2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
   3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
   4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:
   1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
   2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
   3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on 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;
   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 removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) 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 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and

any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. 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, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.

H. 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, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. 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, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. 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 failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the 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 15.08, 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 Contract.

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

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the 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. Contractor 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 Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.

F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.

H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.

D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured

retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.

F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

H. Contractor shall require:
   1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
   2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

I. If either party does not purchase or maintain the insurance required of such party by the Contract, 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.

J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.

K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.

M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.
N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

A. *Required Insurance*: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.
B. *General Provisions*: The policies of insurance required by this Paragraph 6.03 as supplemented must:
    1. include at least the specific coverages required;
    2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;
    3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;
    4. apply with respect to the performance of the Work, whether such performance is 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; and
    5. include all necessary endorsements to support the stated requirements.
C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:
    1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;
    2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;
    3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);
    4. not seek contribution from insurance maintained by the additional insured; and
    5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.

C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the 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, risks, 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 Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, 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.
2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially

completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.

1. 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 all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.

C. The waivers in this Paragraph 6.05 include the waiver of rights 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 insured peril, risk, or cause of loss.

D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, 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 fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor

shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *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.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *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 maintain good discipline and order at the Site.

B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

C. 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 will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *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, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will 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 must 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.

7.05 *"Or Equals"*

A. *Contractor's Request; Governing Criteria*: Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item 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, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:
    a. in the exercise of reasonable judgment Engineer determines that the proposed item:
        1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
        2) 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;
        3) has a proven record of performance and availability of responsive service; and
        4) is not objectionable to Owner.
    b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:
        1) there will be no increase in cost to the Owner or increase in Contract Times; and
        2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.
3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
   a. will certify that the proposed substitute item will:
      1) perform adequately the functions and achieve the results called for by the general design;
      2) be similar in substance to the item specified; and
      3) be suited to the same use as the item specified.
   b. will state:
      1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
      2) 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
      3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
   c. will identify:
      1) all variations of the proposed substitute item from the item specified; and
      2) available engineering, sales, maintenance, repair, and replacement services.
   d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. 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.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's

denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.

B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.

E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.

F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.

J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.

K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.

L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.

M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *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 an 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 will be disclosed 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.

7.09 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. 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 the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *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.

7.11 *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. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and 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 such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.

C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *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.

B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.

C. 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, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.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 at

its expense (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).

E. 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.

F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.

H. 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.

I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).

J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as 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.

7.15 *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 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 by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:
   a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the 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;

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 the Work; and
3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;

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 Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.
3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must 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*: Contractor 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. Contractor shall submit the number of copies required in the 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 Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.
2. *Samples*
a. Contractor shall submit the number of Samples required in the Specifications.
b. Contractor 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 7.16.C.
3. 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. *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 Work, comply with the requirements of 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, 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 Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.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 Contract Documents in a Field Order or other appropriate Contract modification.
5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or 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 Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

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

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*
1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:
    a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the 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 Contract Documents as to general form and content of the Submittal.
    d. If any such Submittal is not accepted, Contractor 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 2.03. 2.04, and 2.05.

F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *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 is entitled to rely on Contractor's warranty and guarantee.

B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:

1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.

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

1. abuse, or improper modification, 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.

D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:

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;
6. The issuance of a notice of acceptability by Engineer;
7. The end of the correction period established in Paragraph 15.08;
8. Any inspection, test, or approval by others; or
9. Any correction of defective Work by Owner.

E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, 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 losses, damages, costs, and judgments (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 from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage 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 7.18.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 Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.

C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.19;
2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.

G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.

D. 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.

E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, 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.

F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
   1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
   2. An itemization of the specific matters to be covered by such authority and responsibility; and
   3. The extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.

1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) 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 any such claims, and against all 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 damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *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.

9.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *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 (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

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.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *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.

10.02 *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 10.07. 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.

10.03 *Resident Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

A. Engineer has the authority to reject Work in accordance with Article 14.

B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.

C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.

D. Engineer's authority as to changes in the Work is set forth in Article 11.

E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, 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, will 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 Contractor under Paragraph 15.06.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 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

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

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

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

11.02 *Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:
   1. Changes in 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;
   2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
   3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, 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 Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.

B. If Owner or Contractor 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 *Work Change Directives*

A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

B. If Owner has issued a Work Change Directive and:
   1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.
   2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Work if the changes 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. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.

B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-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. Changes involving the

design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

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

C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *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, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.

B. 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, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);
   2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
   3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will 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 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
      b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 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 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such

subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;

d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.
B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.
B. *Change Proposal Procedures*
   1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
   2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.
      a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
      b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

      The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.
   3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting

a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.

4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.
5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

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 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.

ARTICLE 12—CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:
   1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
   2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
   3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
   4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting

data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*
   1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
   2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
   3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
   1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or
   2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will 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 in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will 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 accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will 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, which 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 will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
   4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
   5. Other costs consisting of 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, 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.
         1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.
      c. *Construction Equipment Rental*
         1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any

surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.

3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed 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 builder's risk or other property insurance established in accordance with Paragraph 6.04), 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 include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will 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 communication 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 that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general 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 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. The cost of purchasing, renting, or furnishing small tools and hand tools.

3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
5. 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.
6. Expenses incurred in preparing and advancing Claims.
7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*
1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:
   a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.
   b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:
      1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.
      2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.
2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 *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*: Contractor agrees that:
1. 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
2. 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 for any of the foregoing will be valid.

C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's 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 for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 *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. Payments to Contractor for Unit Price Work will be based on actual quantities.
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. 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, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.
E. *Adjustments in Unit Price*
    1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
        a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
        b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
    2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
    3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction 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 with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.

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, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
3. by manufacturers of equipment furnished under the Contract Documents;
4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. 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. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages 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. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then 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, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages 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 pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
2. 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, 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, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *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, then 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 will 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.

14.07 *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 defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, 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, 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 incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. 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 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. *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.
2. 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 must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by

appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *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 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 13.03, 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; 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;
   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
   c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
   d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; 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 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
   a. the Work is defective, requiring correction or replacement;
   b. the Contract Price has been reduced by Change Orders;
   c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
   e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*
   1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*
   1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
      a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, 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. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
      c. Contractor has failed to provide and maintain required bonds or insurance;
      d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
      e. Owner 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;
      f. The Work is defective, requiring correction or replacement;
      g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
      h. The Contract Price has been reduced by Change Orders;
      i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
      j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
      k. 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; or

l. Other items entitle Owner to a set-off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, 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, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *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 and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

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 preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing,

Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. 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 punch list.

15.04 *Partial Use or Occupancy*

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. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be 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 15.03.A through 15.03.E for that part of the Work.
2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work 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 15.03 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 6.04 regarding builder's risk or other property insurance.

15.05 *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, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *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, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.

2. The final Application for Payment must be accompanied (except as previously delivered) by:
   a. all documentation called for in the Contract Documents;
   b. consent of the surety, if any, to final payment;
   c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.
   d. a list of all duly pending Change Proposals and Claims; and
   e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) 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, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Final Application and Recommendation of Payment*: 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 have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. 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. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.

D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.

E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim, appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *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 Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such adjacent areas;
2. correct such defective Work;
3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.

B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.

C. If, after receipt of a notice of defect within 60 days and within the correction period, 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. Contractor shall pay all 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). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

D. 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.

E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, 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.

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

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *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 written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and 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);
   2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
   3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
   4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:
   1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and
   2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, 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 complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.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 the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds 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.

F. 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, or any rights or remedies of Owner against Contractor or any surety under any payment

bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

A. Upon 7 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; and
   3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 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 16.03.

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, 7 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 are not intended to preclude Contractor from submitting a Change Proposal 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 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this article:
   1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and
   2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this article, Owner or Contractor may:
   1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;
   2. agree with the other party to submit the dispute to another dispute resolution process; or
   3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only 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.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract 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.

18.03 *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. 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.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *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 Contract.

18.06 *Survival of Obligations*

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

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

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

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Section 00 73 00 - SUPPLEMENTARY CONDITIONS

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

These Supplementary Conditions amend or supplement EJCDC® C-700, Standard General Conditions of the Construction Contract (2018). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, “Paragraph SC-4.05.”

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SC-1. DEFINITIONS AND TERMINOLOGY

SC-1.01. Defined Terms. Delete and replace definitions 16, 22, 30, 37, and 50 in Paragraph 1.01.A with the following:

16. Contractor--The individual or entity with which Owner has contracted for the performance of the Work. The terms Contractor and CONTRACTOR are interchangeable and shall have the same meaning in the Contract Documents.

22. Engineer--The individual or entity named as such in the Agreement. The terms Engineer and ENGINEER are interchangeable and shall have the same meaning in the Contract Documents.

30. Owner--The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract. The terms Owner and OWNER are interchangeable and shall have the same meaning in the Contract Documents.

37. Shop Drawings—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether reviewed or not, are not Drawings and are not Contract Documents.

50. Work Change Directive—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner ordering an addition, deletion, or revision in the Work.

SC-1.01. Defined Terms. Add the following definitions to Paragraph 1.01.A:

53. Float--The amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any of the activities in the Progress Schedule.

54. Geotechnical Baseline Report (GBR)—The interpretive report prepared by or for Owner regarding subsurface conditions at the Site, and containing specific baseline geotechnical conditions that may be anticipated or relied upon for bidding and contract administration purposes, subject to the controlling provisions of the Contract, including the GBR's own terms.
55. Geotechnical Data Report (GDR)—The factual report that collects and presents data regarding actual subsurface conditions at or adjacent to the Site, including Technical Data and other geotechnical data, prepared by or for Owner in support of the Geotechnical Baseline Report. The GDR's content may include logs of borings, trenches, and other site investigations, recorded measurements of subsurface water levels, the results of field and laboratory testing, and descriptions of the investigative and testing programs. The GDR does not include an interpretation of the data. If opinions, or interpretive or speculative non-factual comments or statements appear in a document that is labeled a GDR, such opinions, comments, or statements are not operative parts of the GDR and do not have contractual standing. Subject to that exception.

SC-1.02. Terminology. Insert new Paragraph 1.02.H in its entirety:

H. Without Exception.

1. The term "without exception", when used in the Contract Documents following the name of a Supplier or a proprietary item of equipment, product, or material, shall mean that the sources of the product are limited to the listed Suppliers or products and that no similar, equivalent, or "or-equal" item and no substitution will be permitted.

SC-2. PRELIMINARY MATTERS

SC-2.02 Copies of Documents. Amend the first sentence of Paragraph 2.02.A. to read as follows:
Owner shall furnish to Contractor **six (6)** printed copies of the Contract Documents (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF).

SC-2.02 Copies of Documents. Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

A. Owner shall furnish to Contractor **six (6)**printed copies of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated prior to the Effective Date of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

SC-3. CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

SC-3.03. Reporting and Resolving Discrepancies. Add the following new sentence at the end of Paragraph 3.03.B:

The Drawings are intended to conform and agree with the Specifications; if, however discrepancies occur, the ENGINEER will decide which shall govern. Special specifications stated on the Drawings govern that particular piece of Work and have equal weight and importance as the printed specifications. In the event of any discrepancies between the Drawings and the figures written thereon, the figures are to be taken as correct.

SC-4. COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.03. Add the following new paragraphs immediately after paragraph 4.03.A. of the General Conditions, which is to read as follows:

B. It will be the CONTRACTOR'S responsibility to flag, protect, or provide offset references for the remonumentation of any property corners or rights-of-way markers that are disturbed by the Work on the Project. In the even these markers are damaged or removed, it will be the CONTRACTOR'S responsibility to re-establishthose markers that were present prior to Work on the project.

C. It shall be the CONTRACTOR'S responsibility to verify all reference points shown on the Contract Documents prior to beginning Work on the site. This verification shall be conducted by professionally qualified personnel in a manner that will verify the accuracy of the information shown in the Contract Documents. On projects that involve the connection to, or additions to existing structures, the elevations of existing structures shall also be verified. Any finding that differs from information shown on the Contract Documents shall be submitted to the ENGINEER for resolution.

D. Additional surveys necessary for the construction staking shall be performed by the CONTRACTOR, the cost of which shall be incorporated into the appropriate items of Work. On projects in which payment is classified by depth of cut, the construction staking shall be performed in a manner that will allow for the determination of cut classification if the classification is to be other than what is shown in the Contract Documents. During construction of the project, the CONTRACTOR shall keep a daily log and record of the location of all underground pipes, all structures, and any deviation from the plans. The CONTRACTOR shall keep and furnish this daily log and record in a manner that will allow the ENGINEER to incorporate these items into the Contract Documents.

E. The reports of subsurface information shall be available as a separate document to the Contract Documents.

SC-5. SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.03 Subsurface and Physical Conditions. Add the following new paragraphs immediately after Paragraph 5.03.D:

E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Prepared By	Date of Report	Number of Pages	Technical Data
Bridgeport Utilities, Water-Wastewater; Geotechnical Data Report	Terracon	July 9, 2026	108	The Technical Data contained in such report upon whose accuracy Contractor may rely are those indicated in the definition of Technical Data in the General Conditions, except that Contractor may only rely on the results of rock core information shown on Boring logs W-1 and W-2. The Contractor shall not rely on location of these two borings as shown in Terracon report or on the Drawings, the depth to soil in river bottom measured from river surface level, or on the thickness of soil overlying the bedrock surface.

F. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Prepared by	Date of Drawings	Number of Pages	Technical Data
Project No. 101-W63	Nelson & Company, PC	February 20, 2018	90	The contractor may rely on the easement location and stationing shown as it pertains to the existing Cooling Water Force Main (W63C) for the installation of Air Vacuum Valve assemblies indicated in Section 40 05 86-S01 Air Valves Schedule. The drawing set was Issued for Construction but is not a Record Drawing set. The Contractor shall not rely the location or elevation of the Cooling Water Force Main or locations and elevations of the adjacent utilities indicated within the boundaries of the easement.

SC-5.05. Underground Facilities. Add the following new paragraph immediately after Paragraph 5.05.F of the General Conditions:

G. Generally, service connections are not indicated on the Drawings. Contractor shall be responsible for discovery of existing underground installations, in advance of excavating or trenching, by contacting all local utilities and by prospecting.

SC-5.06 Hazardous Environmental Conditions. Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
No such report		

5. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawings Title	Prepared by	Date of Drawings	Number of Pages	Technical Data
No such drawing				

SC-6. BONDS AND INSURANCE

SC-6.03 Contractor's Insurance. Supplement Paragraph 6.03 with the following provisions after Paragraph 6.03.C:

1.02

E. Workers' Compensation and Employer's Liability: Contractor shall purchase and maintain workers' compensation and employer's liability insurance, including, as applicable, United States Longshoreman and Harbor Workers' Compensation Act, Jones Act, stop-gap employer's liability coverage for monopolistic states, and foreign voluntary workers' compensation (from available sources, notwithstanding the jurisdictional requirement of Paragraph 6.02.B of the General Conditions).

Workers' Compensation and Related Policies	Policy limits of not less than:
Workers' Compensation	
State	Statutory
Applicable Federal (e.g., Longshoreman's)	Statutory
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory
Employer's Liability	
Each accident	$1,000,000
Each employee	$1,000,000
Policy limit	$1,000,000

F. Commercial General Liability—Claims Covered: Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:
   1. damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees,
   2. damages insured by reasonably available personal injury liability coverage, and
   3. damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

G. Commercial General Liability—Form and Content: Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form) and include the following coverages and endorsements:
   1. Products and completed operations coverage.
      a. Such insurance must be maintained for three years after final payment.
      b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
   2. Blanket contractual liability coverage, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
   3. Severability of interests and no insured-versus-insured or cross-liability exclusions.
   4. Underground, explosion, and collapse coverage.
   5. Personal injury coverage.
   6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). If Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available, then Contractor may satisfy this requirement by providing equivalent endorsements.
   7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04 "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

H. Commercial General Liability—Excluded Content: The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:
   1. Any modification of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).

2. Any exclusion for water intrusion or water damage.
3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
4. Any exclusion of coverage relating to earth subsidence or movement.
5. Any exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than worker's compensation).
6. Any limitation or exclusion based on the nature of Contractor's work.
7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.

I. Commercial General Liability—Minimum Policy Limits

Commercial General Liability	Policy limits of not less than:
General Aggregate	$4,000,000
Products—Completed Operations Aggregate	$2,000,000
Personal and Advertising Injury	$1,000,000
Bodily Injury and Property Damage—Each Occurrence	$2,000,000

J. Automobile Liability: Contractor shall purchase and maintain automobile liability insurance 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. The automobile liability policy must be written on an occurrence basis.

Automobile Liability	Policy limits of not less than:
Bodily Injury	
Each Person	$1,000,000
Each Accident	$1,000,000
Property Damage	
Each Accident	$1,000,000
[or]	
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	$2,000,000

K. Umbrella or Excess Liability: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the Paragraphs above. The coverage afforded must be at least as broad as that of each and every one of the underlying policies.

Excess or Umbrella Liability	Policy limits of not less than:
Each Occurrence	$ 10,000,000
General Aggregate	$ 10,000,000

M. Contractor's Pollution Liability Insurance: Not used.

P. Unmanned Aerial Vehicle Liability Insurance: If Contractor uses unmanned aerial vehicles (UAV—commonly referred to as drones) at the Site or in support of any aspect of the Work, Contractor shall obtain UAV liability insurance in the amounts stated; name Owner, [Consulting Engineer,][Engineer,]and all individuals and entities identified in the Supplementary Conditions as additional insureds; and provide a certificate to Owner confirming Contractor's compliance with this requirement. Such insurance will provide coverage for property damage, bodily injury or death, and invasion of privacy.

Unmanned Aerial Vehicle Liability Insurance	Policy limits of not less than:
Each Claim	$1,000,000
General Aggregate	$2,000,000

SC-6.04 Builder's Risk and Other Property Insurance. Supplement Paragraph 6.04 of the General Conditions with the following provisions:

F. Builder's Risk Requirements: The builder's risk insurance must:

1. be written on a builder's risk "all risk" policy form that at a minimum includes insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment stored and in transit, and must not exclude the coverage of the following risks: fire; windstorm; hail; flood; earthquake, and other earth movement; lightning; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; and water damage (other than that caused by flood).
    a. Such policy will include an exception that results in coverage for ensuing losses from physical damage or loss with respect to any defective workmanship, methods, design, or materials exclusions.
    b. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake, volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance will be provided through other insurance policies acceptable to Owner and Contractor.
2. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
3. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of contractors, engineers, and architects).

4. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier). If this coverage is subject to a sublimit, such sublimit will be a minimum of $**500,000**.
5. extend to cover damage or loss to insured property while in transit. If this coverage is subject to a sublimit, such sublimit will be a minimum of $**500,000**.
6. allow for the waiver of the insurer's subrogation rights, as set forth in this Contract.
7. allow for partial occupancy or use by Owner by endorsement, and without cancellation or lapse of coverage.
8. include performance/hot testing and start-up, if applicable.
9. be maintained in effect until the Work is complete, as set forth in Paragraph 15.06.D of the General Conditions, or until written confirmation of Owner's procurement of property insurance following Substantial Completion, whichever occurs first.
10 include as named insureds the Owner, Contractor, Subcontractors (of every tier), and any other individuals or entities required by this Contract to be insured under such builder's risk policy. For purposes of Paragraphs 6.04, 6.05, and 6.06 of the General Conditions, and this and all other corresponding Supplementary Conditions, the parties required to be insured will be referred to collectively as "insureds."

SC-7. CONTRACTOR'S RESPONSIBILITIES

SC-7.03. Labor; Working Hours. Add the following new Paragraph immediately after Paragraph 7.03.C:

1. Regular working hours for this project are Monday through Friday between the times of 7:00 A.M. and 6:00 P.M. Approval for work outside of regular working hours requires City Council approval, and work performed beyond regular working hours shall be done at no additional cost to OWNER. CONTRACTOR shall reimburse OWNER for all extra costs associated with such work including additional support services, engineering services, inspection services, testing services, utilities or other applicable costs. The ENGINEER will determine the extent of additional services needed due to CONTRACTOR'S working outside regular work hours.

B. When applicable, the CONTRACTOR shall provide a written tab all taxes, including sales and use taxes, paid by the CONTRACTOR. This is to assist the OWNER in obtaining any available sales and/or use tax exemptions, credits, or refunds for eligible machinery, equipment, or materials used in connection with the Work, as permitted under applicable laws of the State of Alabama. Such written tabulation shall be included with each partial payment request. Any refunds, exemptions, or credits obtained shall accrue to the OWNER.

SC-7.11. Laws and Regulations Add the following new paragraph after 7.11.C:

D. Safety and Health Regulations. OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR Part 1926, shall apply to Work under this Contract. The U.S. Department of Labor will be responsible for compliance review and enforcement of the regulations.

SC-7.12. Record Documents. Delete Paragraph 7.12.A in its entirety and insert the following Paragraphs 7.12.A and 7.12.B in it its place:

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and accepted Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all accepted Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

B. Record documents shall be maintained in accordance with the following:
   1. Contract document Record Drawings shall be PDF files of the Contract Documents with markups clearly depicting all differences between original design and as constructed facilities in sufficient detail as to not require any related document (such as RFIs, Change Orders, Field Orders, etc) for interpretation.
   2. Record document markups shall include mark-ups to specifications, drawings or other content comprising the Contract Documents. For specification records, equipment O&M manuals may be cross-referenced if significant differences exist between the Contract Document and the installed equipment.
   3. Contractor is responsible for recording all field changes, even if not documented as part of a formal change documents (RFI, Change Order, etc).
   4. With engineer approval, CAD files may be submitted for buried infrastructure and site work that shows actual survey points with x, y, and z information for building corners, floor elevations, flow lines of gutters, road centerlines, storm sewer inlets, pipe centerlines, buried valves, fittings, elbows, crossings of other utilities, manhole inverts, etc. Each item should be clearly labeled and located on independent layers that match the CAD file provided by the Engineer at the start of the project. Sufficient points shall be provided for ground surface where the final grading differs by 6” or greater from the proposed contours.

SC-7.13 Safety and Protection. Insert the following new paragraph K after Paragraph 7.13.J:

K. If not already included in the Contractor’s Safety Program, the Contractor shall supply the necessary resources and support for installation of equipment, and inspection by others, to comply with the following specific provisions:
   1. Fall protection on portable ladder climbs of 12 feet or greater. All fall protection shall meet OSHA standards.
   2. Fall protection shall be required when working from six feet or greater. This includes working from a ladder.
   3. Contractor shall employ a ‘Stop Work’ expectation approach, whereby any on site observer of an unsafe, or suspected unsafe, action can request that work be stopped until the action

of concern is resolved (suspected unsafe action is fixed or observer is satisfied that current action meets safety program requirements).

SC-7.16. Submittals. Delete Paragraph 7.16 in its entirety and replace it with the following:

F. Shop Drawings Samples, and Other Submittals. Requirements for shop drawings, samples, and submittal procedures shall be as specified in Division 1 Submittals Procedures section. Fabrication that proceeds prior to acceptance of submittals by Engineer shall be at Contractor's risk.

SC-7.19. Delegation of Professional Design Services. Delete Paragraph 7.19.E in its entirety, and replace with the following Paragraph 7.19.E:

E. Pursuant to this Paragraph 7.19, Engineer's review, acceptance, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
   1. Checking for conformance with the requirements of this Paragraph 7.19;
   2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
   3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

SC-8. OTHER WORK AT THE SITE

SC-8.02. Coordination. Add to Paragraph 8.02.B:

C. If OWNER contracts with others for the performance of other work on the Project site, the CONTRACTOR shall attend and participate in coordination meetings with the other on-site Contractors.

D. Should CONTRACTOR cause damage to the work or property of any separate of contractor at the site, or should any claim arising out of or resulting from CONTRACTOR'S performance of the Work at the site be made by any separate contractor against CONTRACTOR, OWNER, ENGINEER or ENGINEER'S Consultants or any other person, CONTRACTOR shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by mediation, arbitration, or at the law. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold OWNER, ENGINEER and ENGINEER's Consultants and the officers, directors, employees, agents, and other consultants of each and any of them harmless 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 directly, indirectly or consequentially out of or resulting from any action, legal or equitable, brought by a separate contractor against OWNER, ENGINEER, or ENGINEER'S Consultants or the officers, directors, employees, agents, or other consultants of each and any of them to the extent based on a claim caused by, arising out of, or resulting from CONTRACTOR'S performance of Work. Should a separate contractor cause damage to the Work or property of CONTRACTOR or should the performance of work by any separate contractor at the site give rise to any other claim, CONTRACTOR shall not institute any action, legal or equitable, against OWNER, ENGINEER, or ENGINEER'S Consultants or the officers, directors, employees, agents, or other consultants of each and any of them or permit any action against

any of them to be maintained and continued in its name for its benefit in any court or before any mediator or arbitrator which seeks to impose liability on or to recover damages from OWNER, ENGINEER, or ENGINEER'S Consultants or the officers, directors, employees, agents, or other consultants of each and any of them on account of any such damage or claim. If CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor and OWNER and CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CONTRACTOR may make a claim for an extension of time in accordance with Article 12. An extension of the Contract Times shall be CONTRACTOR'S exclusive remedy with respect to OWNER, ENGINEER, or ENGINEER'S Consultants or the officers, directors, employees, agents, or other consultants of each and any of them for any delay, disruption, interference or hindrance caused by any separate contractor. This paragraph does not prevent recovery from OWNER, ENGINEER, or ENGINEER'S Consultants or the officers, directors, employees, agent, or other consultants of each and any of them for activities that are their respective responsibilities.

SC-9. OWNER'S RESPONSIBILITIES

SC-9.01. Communications to Contractor. Delete Paragraph 9.01.A in its entirety, and replace it with the following:

A. Except as otherwise provided in these General Conditions, if Owner issues communications to Contractor, a copy shall be provided to Engineer.

SC-10. ENGINEER'S STATUS DURING CONSTRUCTION

SC-10.01. Owner's Representative. Add the following sentence at the end of Paragraph 10.01.A: The action of Engineer in performance of these duties shall not be construed to make Engineer the Agent for Owner with respect to changes in the Cost of the Work or changes in the Contract Documents.

SC-10.03. Resident Project Representative. Add the following new paragraph10.03.A.1 immediately after Paragraph 10.03.A:

1. The duties, responsibilities, and limitation of authority of the Resident Project Representative (if provided by Engineer) are set forth in an attachment to the Supplementary Conditions : the Resident Project Representative will be authorized to review the Work and products furnished, but the Resident Project Representatives will not be authorized to alter or waive any requirements of the Contract Documents..

SC-11. CHANGES TO THE CONTRACT

SC-11.08. Change of Contract Times. Add the following new paragraphs after Paragraph 11.08.B:

C. A Change Proposal for an adjustment of the Contract Times (or Milestones), otherwise allowable under the Contract Documents, shall be granted only to the extent the time lost exceeds the Float for the delayed activity at the time of the event giving rise to the claim. Float, whether expressly disclosed or implied in any manner, is jointly owned by the project participants.

D. Contractor shall not use Float suppression techniques (including, but not limited to, preferential sequencing caused by late starts of follow-up trades, unreasonably small crews, extended durations, or imposed dates) in information provided to Engineer.

SC-12. CLAIMS

No Modifications

SC-13. COST OF WORK; ALLOWANCES, UNIT PRICE WORK

No Modifications

SC-14. TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

SC-14.01. Access to Work.
Add the following subparagraph 14.01.A.1:

1. Contractor shall provide suitable attachment points for fall protection devices to be used by Engineer where Engineer is required to use Contractor's portable ladders to access portions of the Work where climbing height exceeds 12'-0". Fall protection devices shall be provided by Engineer for attachment by Contractor.

SC-15. PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

SC-15.01. Progress Payments. Add the following, as numbered items, to the list of items in Paragraph 15.01.B:

5. Schedules and Data. During the progress of the Work, each application for Payment shall be accompanied by the following:
   a. Contractor's updated Progress Schedule
   b. Narrative summary of schedule progress
   c. Submittal status report
   d. Values of materials and equipment on hand
   e. Maintenance reports for stored equipment requiring maintenance.
   f. Detailed Schedule of Values including a breakdown of labor, materials, equipment, subcontractors, and other major cost components in sufficient detail to enable Bridgeport Utilities to accurately evaluate and process payment applications.

SC-15.01. Progress Payments. Delete Paragraph 15.01.D.1 in its entirety and insert the following text in its place:

1. Prompt Payment

a. Owner and Contractor agree that all partial payments and final payments shall be made in accordance with the terms of these Contract Documents and applicable laws of the State of Alabama.
b. Interest Rate: For purposes of computing interest on late payments, the rate of interest shall be one percent (1.0%) per month, or a pro-rata fraction thereof, on the unpaid balance, unless otherwise required by applicable Alabama law.
c. Payment Periods:
    1) When the Contractor has performed in accordance with the provisions of these Contract Documents, the Owner shall pay the Contractor within thirty (30) days of receipt by the Owner or the Owner's representative of any properly completed Application for Payment, based upon work completed or services provided pursuant to the terms of these Contract Documents, unless otherwise agreed in writing.
d. When a subcontractor has performed in accordance with the provisions of its subcontract and all conditions precedent to payment have been satisfied, the Contractor shall pay to that subcontractor, and each subcontractor shall pay to its subcontractors, within seven (7) days after receipt of payment, the full amount received for such subcontractor's work and materials based on work completed or services provided under the subcontract, less retainage expressed as a percentage. Such retainage shall not exceed that retained by the Owner, provided the subcontractor has provided reasonable assurances of continued performance and financial responsibility as may be required by the Contractor.
e. Interest on Late Payment: Except as otherwise provided in these Contract Documents, if a periodic or final payment to the Contractor is delayed beyond the time specified above, or if payment to a subcontractor is delayed beyond seven (7) days after receipt of payment, the Owner, Contractor, or subcontractor, as applicable, shall pay interest on the unpaid amount beginning on the day following the due date at the rate specified herein. Interest shall be computed monthly or on a pro-rata basis. No compound interest shall apply.
f. Notice of Late Payment and Request for Interest: Any party seeking interest on late payment shall provide written notice to the party responsible for payment. Such notice shall:
    1) State that interest is being claimed for late payment;
    2) Specify the amount due; and
    3) Identify the date on which interest is claimed to begin accruing.
g. Notice shall be provided in a reasonable manner consistent with the notice provisions of the Contract Documents.

2. These notice provisions are a condition precedent to recovery of interest. Failure to provide such notice shall constitute a waiver of any claim for interest on late payment.
    a. Integration: Unless otherwise provided in these Contract Documents, the provisions of this Prompt Payment clause shall govern payment obligations between the parties and supersede any inconsistent general provisions related to timing of payments or interest.

SC-15.03. Substantial Completion. Add the following new paragraphs immediately after Paragraph 15.03.A:

1. "Substantial Completion" means that the facilities are completed to the point that wastewater can be adequately treated and no nuisance is created, to the satisfaction of Engineer. All process equipment shall be installed and operational, or temporary arrangements satisfactory to Owner shall have been made. All performance testing need not have been completed prior to the date of Substantial Completion.

SC-15.03 Substantial Completion. Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, will be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under this Article 15.

SC-15.05. Final Inspection. Delete Paragraph 15.05.A in its entirety and insert the following in its place:

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make make a final review of construction with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

SC-15.08. Correction Period. Add the following new paragraph immediately after Paragraph15.08.E:

G. The correction period set forth in Paragraph 15.08.A shall be two years in lieu of one year. All other provisions of Paragraph 15.08.A shall remain unchanged.

SC-16. SUSPENSION OF WORK AND TERMINATION

No modifications.

SC-17. FINAL RESOLUTIONS OF DISPUTES

SC-17.02 Arbitration. Add the following new paragraph immediately after Paragraph 17.01.

17.02 Arbitration

A. All matters subject to final resolution under this Article will be settled by arbitration administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules. Any controversy or claim in the amount of $100,000 or less will be settled in accordance with the American Arbitration Association's supplemental rules for Fixed Time and Cost Construction Arbitration. This agreement to arbitrate will be specifically enforceable under the prevailing law of any court having jurisdiction.

B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitration administrator, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in Article 17, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event will any such demand be made after the date when institution of legal or

equitable proceedings based on such matter in question would be barred by the applicable statute of limitations.

C. The arbitrator(s) must be licensed engineers, contractors, attorneys, or construction managers. Hearings will take place pursuant to the standard procedures of the Construction Arbitration Rules that contemplate in-person hearings. The arbitrators will have no authority to award punitive or other damages not measured by the prevailing party's actual damages, except as may be required by statute or the Contract. Any award in an arbitration initiated under this clause will be limited to monetary damages and include no injunction or direction to any party other than the direction to pay a monetary amount.

D. The Arbitrators will have the authority to allocate the costs of the arbitration process among the parties, but will only have the authority to allocate attorneys' fees if a specific Law or Regulation or this Contract permits them to do so.

E. The award of the arbitrators must be accompanied by a reasoned written opinion and a concise breakdown of the award. The written opinion will cite the Contract provisions deemed applicable and relied on in making the award.

F. The parties agree that failure or refusal of a party to pay its required share of the deposits for arbitrator compensation or administrative charges will constitute a waiver by that party to present evidence or cross-examine witness. In such event, the other party shall be required to present evidence and legal argument as the arbitrator(s) may require for the making of an award. Such waiver will not allow for a default judgment against the non-paying party in the absence of evidence presented as provided for above.

G. No arbitration arising out of or relating to the Contract will include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants, and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:

1. the inclusion of such other individual or entity will allow complete relief to be afforded among those who are already parties to the arbitration;
2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration, and which will arise in such proceedings;
3. such other individual or entity is subject to arbitration under a contract with either Owner or Contractor, or consents to being joined in the arbitration; and
4. the consolidation or joinder is in compliance with the arbitration administrator's procedural rules.

H. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.

I. Except as may be required by Laws or Regulations, neither party nor an arbitrator may disclose the existence, content, or results of any arbitration hereunder without the prior written consent of both parties, with the exception of any disclosure required by Laws and Regulations or the Contract. To the extent any disclosure is allowed pursuant to the exception, the disclosure must be strictly and narrowly limited to maintain confidentiality to the extent possible.

SC-17.03 Attorneys' Fees. Add the following new paragraph immediately after Paragraph 17.02.

17.03 Attorneys' Fees

A. For any matter subject to final resolution under this Article, the prevailing party shall be entitled to an award of its attorneys' fees incurred in the final resolution proceedings, in an equitable amount to be determined in the discretion of the court, arbitrator, arbitration panel,

or other arbiter of the matter subject to final resolution, taking into account the parties' initial demand or defense positions in comparison with the final result.

SC-18. MISCELLANEOUS

No Modifications

End of Section

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PART 1 - Section 01 11 13 - WORK COVERED BY CONTRACT DOCUMENTS

PART 2 - GENERAL

2.1 GENERAL DESCRIPTION OF WORK.

A. The Work to be performed under these Contract Documents is generally described but not limited to as follows:

1. Construction of a new chemical storage and handling building, new chlorine contact basin, new treated water outfall to the Tennessee River, and installation of associated piping and electrical infrastructure.

2. Installation of new brush aerators in existing wastewater lagoons.

3. Installation of new vertical diffusion vane pumps and associated upgrades at Widows Creek Pump Station. Installation of new air release valves on existing cooling water pipeline.

1

B. Portions of the Work are located on or adjacent to Tennessee Valley Authority (TVA) property and are subject to requirements of the TVA Section 26a Permit and other applicable TVA approvals. The Contractor shall comply with all permit conditions and restrictions applicable to the Work.

1

1. In-Water Work Restrictions

a. In-water construction activities within TVA jurisdiction shall be scheduled during the TVA winter drawdown period, beginning after Labor Day and extending through the reservoir drawdown to winter pool, in accordance with permit requirements.

C. TVA has established measures to minimize impacts to federally listed bat species in accordance with Section 7 of the Endangered Species Act.

1

1. Tree Clearing Restrictions

a. Tree clearing conducted between November 16 and March 14 will not require a contribution to the TVA Bat Conservation Fund.
b. Tree clearing between May 15 and July 31 shall be avoided unless otherwise notified and approved by TVA.
c. Tree clearing conducted outside the periods specified above in a and b may require a contribution to the TVA Bat Conservation Fund if suitable bat habitat is identified for removal. Any required contribution shall be

determined by TVA based on the acreage of affected habitat, habitat location, and time of year of clearing.

2.2 UNITS OF MEASUREMENT.

A. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

2.3 MEASUREMENT AND PAYMENT.

A. Scope

1. This section covers methods of measurement and payment for items of Work under this Contract.

B. General

1. The Contract Price shall cover all Work required by the Contract Documents. All costs in connection with the proper and successful completion of the Work, including furnishing all materials, equipment, supplies, and appurtenances; providing all construction plant, equipment, and tools; and performing all necessary labor and supervision to fully complete the Work, shall be included in the unit and lump sum prices bid. All Work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid.

C. Estimated Quantities

1. All estimated quantities stipulated in the Bid or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the Bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. Contractor agrees that it will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts therefore.

D. Allowance

1. Owner’s Cash Allowance

a. The Contract Price includes the Owner’s Cash Allowance identified in the Bid Form. The Cash Allowance is established solely for payment of specific Work, materials, equipment, services, or other items as directed and authorized by Owner.

b. Expenditure of the Cash Allowance shall occur only upon written authorization by Owner. Amounts paid from the Allowance shall be adjusted by Change Order to reflect the actual costs incurred.
c. Any portion of the Cash Allowance not utilized at Final Completion shall be credited to Owner by deductive Change Order.

2. Owner's Contingency Allowance:

a. The Contract Price includes an Owner's Contingency Allowance for unforeseen conditions, additional work, quantity overruns, design refinements, or other Owner-directed changes within the general scope of the Work.
b. Use of the Contingency Allowance shall require prior written authorization by Owner and shall be documented through a Change Order or other written modification to the Contract.
c. Payments made from the Contingency Allowance shall be based on actual approved costs in accordance with the Contract Documents.
d. Any unused portion of the Contingency Allowance shall remain the property of Owner and shall be deducted from the Contract Price by Change Order prior to Final Payment.
e. Inclusion of the Contingency Allowance in the Contract Price does not constitute authorization for Contractor to perform additional work without Owner's written approval.

2.4 WORK BY OWNER

A. Owner shall perform certain activities in connection with the Project with its own personnel as follows:

1. Procurement and installation of new gas service line to the chemical building

2.5 RESPONSIBILITY FOR MATERIALS AND EQUIPMENT

A. Items Furnished by Contractor.

1. Contractor shall be fully responsible for all materials and equipment which it has furnished.

2.6 OFFSITE STORAGE.

A. Offsite storage arrangements shall be approved by Owner for all materials and equipment not incorporated into the Work but included in Applications for Payment. Such offsite storage arrangements shall be presented in writing and shall afford adequate and satisfactory security and protection. Offsite storage facilities shall be accessible to Owner and Engineer.

2.7 SUBSTITUTES AND "OR-EQUAL" ITEMS.

A. Whenever a material or article is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, the specified item shall be understood as establishing the type, function, and quality desired. Requests for review of equivalency will not be accepted from anyone except Contractor, and such requests will not be considered until after the Contract has been awarded. Other manufacturers' products may be accepted, provided sufficient information is submitted to allow Engineer to determine that the products proposed are equivalent to those named. Such items shall be submitted for review by the procedure set forth in the Submittals Procedures section.

2.8 PREPARATION FOR SHIPMENT.

A. All materials shall be suitably packaged to facilitate handling and protect against damage during transit and storage. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

B. Each item, package, or bundle of material shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

2.9 SALVAGE OF MATERIALS AND EQUIPMENT.

A. Existing materials and equipment removed and not reused as a part of the Work shall become Contractor's property.

B. Contractor shall carefully remove, in a manner to prevent damage, all materials and equipment specified or indicated to be salvaged and reused or to remain the property of Owner. Contractor shall store and protect salvaged items specified or indicated to be reused in the Work .

C. Salvaged items not to be reused in the Work, but to remain Owner's property shall be delivered by Contractor in good condition to Owner.

D. Any items specified or indicated to be salvaged which are damaged in removal, storage, or handling through carelessness or improper procedures shall be replaced by Contractor in kind or with new items.

E. Contractor may furnish and install new items instead of those specified or indicated to be salvaged and reused , in which case such removed items will become Contractor's property.

F. Existing materials and equipment removed by Contractor shall not be reused in the Work , except where so specified or indicated.

2.10 LAND FOR CONSTRUCTION PURPOSES

A. Contractor will be permitted to use available land belonging to Owner, on or near the Site, for construction purposes and for storage of materials and equipment.

B. The locations and extent of the areas so used shall be as indicated on the Drawings.

C. Contractor shall immediately move stored materials or equipment if any occasion arises, as determined by Owner, requiring access to the storage area. Materials or equipment shall not be placed on the property of Owner until Owner has agreed to the location to be used for storage.

2.11 PERMITS

A. Except as listed herein, Contractor shall obtain and pay for all permits necessary to complete the work in accordance with the General Conditions.

B. The following permits will be obtained by the Owner. Copies of these permits will be made available to the Contractor.

1. ~~Emergency Planning and Community Right-to-Know Act - (EPCRA) - Tier II Reporting (40 CFR 355)~~ The list of owner supplied permits will be provided as an addendum.

2.12 OPERATION OF EXISTING FACILITIES

A. The existing treatment plant must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the degree of service provided. Provided permission is obtained from Owner in advance, portions of the existing facilities may be taken out of service for short periods corresponding with periods of minimum service demands.

B. Contractor shall provide temporary facilities and make temporary modifications as necessary to keep the existing facilities in operation during the construction period.

C. Contractor to coordinate electric utility for power service to ensure uninterrupted power service is provided during construction. Based on preliminary discussions with the electric utility, Contractor may elect to install new primary service and transformer as depicted on drawings, which could be used to provide temporary power to existing outdoor motor control centers at the beginning of construction.

2.13 NOTICES TO OWNERS AND AUTHORITIES

A. Contractor shall, as provided in the General Conditions, notify owners of adjacent property and utilities when execution of the Work may affect them.

B. When it is necessary to temporarily deny access to property, or when any utility service connection must be interrupted, Contractor shall give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Utilities and other concerned agencies shall be notified at least 24 hours prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

2.14 LINES AND GRADES

A. All Work shall be done to the lines, grades, and elevations indicated on the Drawings.

B. Contractor shall provide the services of a Professional Land Surveyor (PLS) to establish basic horizontal and vertical control points for use as datums for the Work. All survey, layout, and measurement work shall be performed by Contractor as a part of the Work.

C. Contractor shall provide an experienced instrument person, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement work. In addition, Contractor shall furnish, without charge, competent persons and such tools, stakes, and other materials as Engineer may require , in confirming construction easement boundaries, or in checking survey, layout, and measurement work performed by Contractor.

D. Contractor shall remove and reconstruct work which is improperly located.

2.15 CONNECTIONS TO EXISTING FACILITIES

A. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities, including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electric. In each case, Contractor shall receive permission from Owner or the owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

B. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

2.16 UNFAVORABLE CONSTRUCTION CONDITIONS

A. During unfavorable weather, wet ground, or other unsuitable construction conditions, Contractor shall confine its operations to work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the Work in a proper and satisfactory manner.

2.17 CUTTING AND PATCHING

A. As provided in General Conditions, Contractor shall perform all cutting and patching required for the Work and as may be necessary in connection with uncovering Work for inspection or for the correction of defective Work.

B. Contractor shall perform all cutting and patching required for and in connection with the Work, including but not limited to the following:

1. Removal of improperly timed Work.

2. Removal of samples of installed materials for testing.

3. Alteration of existing facilities.

4. Installation of new Work in existing facilities.

C. Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work and existing facilities during cutting and patching operations. Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without Engineer's concurrence.

D. Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work. Materials shall be removed in a careful manner, with no damage to adjacent facilities or materials. Materials which are not salvable shall be removed from the site by Contractor.

E. All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

2.18 HAZARDOUS ENVIRONMENTAL CONDITIONS AT SITE

A. No Hazardous Environmental Conditions at the Site in areas that will be affected by the Work are known to the Owner.

2.19 CLEANING UP

A. Contractor shall keep the premises free at all times from accumulations of waste materials and rubbish. Contractor shall provide adequate trash receptacles about the Site and shall promptly empty the containers when filled.

B. Construction materials, such as concrete forms and scaffolding, shall be neatly stacked by Contractor when not in use. Contractor shall promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

C. Volatile wastes shall be properly stored in covered metal containers and removed daily.

D. Wastes shall not be buried or burned on the Site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the Site and disposed of in a manner complying with local ordinances and antipollution laws.

E. Adequate cleanup will be a condition for recommendation of progress payment applications.

F. For additional waste management requirements, refer to the Construction Waste Management and Disposal section.

2.20 APPLICABLE CODES

A. References in the Contract Documents to local codes mean the following:

1. Alabama State Building Code - International Building Code (IBC), 2021 Edition
2. International Mechanical Code (IMC), 2021
3. International Plumbing Code (IPC), 2021
4. International Fire Code (IFC), 2021
5. International Fuel Gas Code (IFGC), 2021
6. International Energy Conservation Code (IECC), 2021
7. National Electrical Code (NEC – NFPA 70)
8. Life Safety Code (NFPA 101 HB)
9. National Electrical Safety Code (NESC)
10. Occupational Safety and Health Administration (OSHA)

B. Other standard codes which apply to the Work are designated in the Specifications.

2.21 REFERENCE STANDARDS

A. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to the laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or laws or regulations in effect at the time of opening of Bids (or on the effective date of the Contract or Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

B. However, no provision of any referenced 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, nor shall any such provision or instruction be effective to assign to Owner, Engineer, or any of Engineer's Consultants, agents, or employees, 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.

2.22 PRECONSTRUCTION CONFERENCE

A. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by:

1. Contractor and its superintendent.
2. Principal Subcontractors.
3. Representatives of principal Suppliers and manufacturers as appropriate.
4. Engineer and its Resident Project Representative.
5. Representatives of Owner.
6. Government representatives as appropriate.
7. Others as requested by Contractor, Owner, or Engineer.
8. Principal Subcontractors.
9. Representatives of principal Suppliers and manufacturers as appropriate.
10. Engineer and its Resident Project Representative.
11. Representatives of Owner.
12. Government representatives as appropriate.
13. Others as requested by Contractor, Owner, or Engineer.

B. Unless previously submitted to Engineer, Contractor shall bring to the conference a preliminary schedule for each of the following:

1. Progress Schedule.

2. Procurement schedule.

3. Schedule of Values for progress payment purposes.

4. Schedule of Shop Drawings and other submittals.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include:

1. Contractor's preliminary schedules.

2. Transmittal, review, and distribution of Contractor's submittals.

3. Processing Applications for Payment.

4. Maintaining record documents.

5. Critical Work sequencing.

6. Field decisions and Change Orders.

7. Use of premises, office and storage areas, security, housekeeping, and Owner's needs.

8. Major equipment deliveries and priorities.

9. Contractor's assignments for safety and first aid.

D. Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

2.23 PROGRESS MEETINGS

A. Contractor shall schedule and hold regular progress meetings at least monthly and at other times as requested by Engineer or required by progress of the Work. Contractor, Engineer, and all Subcontractors active on the Site shall be represented at each meeting. Contractor may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.

B. Contractor shall preside at the meetings. Meeting minutes shall be prepared and distributed by Contractor. The purpose of the meetings will be to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

2.24 SITE ADMINISTRATION

A. Contractor shall be responsible for all areas of the Site used by it and by all Subcontractors in the performance of the Work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to Owner or others.

B. Contractor shall have the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except Owner's employees) to observe the same regulations as Contractor requires of its employees.

2.25 USE OF PREMISES.

A. Contractor shall limit site disturbance within the area identified on the Drawings, including earthwork and clearing of vegetation, to 40 feet beyond building or other major structure perimeters; 10 feet beyond surface walkways, patios, surface parking, and trenches for utilities less than 12 inches in diameter; 15 feet beyond primary roadway curbs, main utility trenches, outdoor equipment pads, and electrical equipment yards; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities) that require additional staging areas in order to limit compaction in the constructed area.

2.26 NONSMOKING BUILDING.

A. Contractor’s personnel shall not smoke within 25 feet of entrances, operable windows, or outdoor air intakes for the building. This requirement shall be enforced from the beginning of construction of the super structure.

PART 3 - PRODUCTS (NOT USED)

PART 4 - EXECUTION (NOT USED)

End of Section

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Section 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 General

A. Units of Measurement. When both inch-pound (English) and SI (metric) units of measurement are specified herein, the values expressed in inch-pound units shall govern.

1.2 SCHEDULE OF VALUES.

A. After review of the preliminary schedule at the preconstruction conference, and before submission of the first Application for Payment, Contractor shall prepare and submit to Engineer a Schedule of Values covering each lump sum item. The Schedule of Values, showing the value of each kind of work, shall be acceptable to Engineer before any Application for Payment is prepared.

B. The sum of the items listed in the Schedule of Values shall equal the Contract Price. Such items as Bond premium, temporary construction facilities, and plant may be listed separately in the Schedule of Values, provided the amounts can be substantiated. Overhead and profit shall not be listed as separate items.

C. The Schedule of Values shall have sufficient detail such that partial completion of separable items of work can easily be calculated. The Schedule of Values shall have separate lines for manufacturer's field services, O&M manuals, and performance testing for each item of equipment requiring such services.

D. An unbalanced Schedule of Values providing for overpayment of Contractor on items of Work which would be performed first will not be accepted. The Schedule of Values shall be revised and resubmitted until acceptable to Engineer. Final acceptance by Engineer shall indicate only consent to the Schedule of Values as a basis for preparation of applications for progress payments, and shall not constitute an agreement as to the value of each indicated item.

1.3 SCHEDULE OF PAYMENTS

A. Within 30 days after award of contract, Contractor shall furnish to Engineer a schedule of estimated monthly payments. The schedule shall be revised and resubmitted each time an Application for Payment varies more than 10 percent from the estimated payment schedule.

1.4 SURVEY DATA.

A. All field books, notes, and other data developed by Contractor in performing surveys required as part of the Work shall be available to Engineer for examination throughout the construction period. All such data shall be submitted to Engineer with the other documentation required for final acceptance of the Work.

1.5 LAYOUT DATA.

A. Contractor shall keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Copies of such data shall be furnished to the Resident Project Representative for use in checking Contractor's layout as provided in the project requirements section. All such data considered of value to Owner will be transmitted to Owner by Engineer with other records upon completion of the Work.

End of Section

SECTION 01 32 16 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 GENERAL OVERVIEW.

A. A Progress Schedule shall be used to control the Work and to provide a definitive basis for determining project progress. The Progress Schedule shall be prepared, maintained and updated by Contractor and historical dates agreed monthly with Engineer. Contractor shall submit a preliminary Progress Schedule and a Progress Schedule for acceptance by Engineer. These schedules shall be Contractor's working schedules and shall be used to plan, organize and execute the Work, record and report actual performance and progress, and show how Contractor plans to complete all remaining Work as of the end of each progress report period.

B. The Progress Schedule shall comprise all the detailed construction-related activities using the critical path method (CPM). The Progress Schedule shall provide sufficient detail and clarity to reflect the intricacies and interdependencies of activities so Contractor can plan, schedule, monitor, control and report on the progress of his work. In addition, it shall provide Engineer and Owner a tool to monitor and follow the progress for all phases of the Work.

1.2 PRE-CONSTRUCTION SCHEDULING CONFERENCE.

A. Engineer will conduct a pre-construction scheduling conference with Contractor to review requirements for the schedules including Schedule of Values and schedule configuration. The conference shall be conducted sufficiently early to allow Contractor to submit the preliminary Progress Schedule within ten days of the Effective Date of the Contract.

B. At this meeting, Contractor shall explain in detail the procedure to be used to develop the schedule activity cost-loading or Schedule of Values and cash flow. This procedure is subject to the review and acceptance of Engineer.

1.3 PRELIMINARY PROGRESS SCHEDULE.

A. Following the pre-construction scheduling conference but within ten calendar days after the Effective Date of the Contract, Contractor shall submit a preliminary Progress Schedule for review by Engineer. The preliminary Progress Schedule shall show detailed construction-related activities for the first 60 days of the project. The remainder of the Contract activities shall be shown as summary bars within the milestones of the Work. If Engineer has comments on the preliminary Progress Schedule, Contractor shall make the necessary changes and resubmit it within ten calendar days. No progress

payments will be made during the period specified above for the preliminary Progress Schedule until the preliminary Progress Schedule has been accepted by Engineer.

B. The preliminary Progress Schedule shall:

1. Illustrate a feasible schedule for completion of the Work within the Contract Times and Milestones specified.

2. Provide an elementary example of the schedule in the format to be used for the Progress Schedule.

3. Include the activity code structure as described in Paragraph 19 of this specification.

C. Preliminary Progress Schedule Submittal Format:

1. Contractor shall submit an electronic copy of the preliminary Progress Schedule. File format shall enable the use of the schedule as an executable file as described herein. Files shall be submitted electronically using the submittal methods described in the Submittals section.

2. A brief narrative shall accompany the submittal, describing Contractor's scheduling approach to the project. The narrative shall include a description of the Contract milestones, approach for construction activities during the period of the preliminary Progress Schedule, description of the general approach of the activities for the work beyond the preliminary Progress Schedule period, a description of the project's critical path, identification of critical long-lead submittals, and planned outages.

3. The narrative shall also incorporate activity codes, calendars, weather days, milestone constraints, and work breakdown structure in accordance with the requirements specified herein.

1.4 PROGRESS SCHEDULE.

A. The Progress Schedule comprises all the construction-related activities for the Work and shall show the order in which Contractor proposes to carry out the work. Contractor shall include milestones, coordination necessitated by limited access and available work areas, and the availability and use of manpower, material and equipment. Contractor shall use the Progress Schedule to plan, schedule and coordinate the Work including activities of subcontractors, equipment vendors, and suppliers.

B. The Progress Schedule shall be to the level of detail acceptable to Engineer, and shall include the following:

1. Organization and structural breakdown of the Project;

2. Milestones and completion dates;

3. Type of work to be performed and the labor trades involved;

4. Purchase, manufacture and delivery activities for major materials and equipment;

5. Preparation, submittal, and acceptance of shop drawings and material samples;

6. Deliveries of owner-furnished equipment and/or materials;

7. Acceptances required by regulatory agencies and/or other third parties;

8. Assignment of responsibility for each activity;

9. Access requirements to work areas;

10. Identification of interfaces and dependencies with preceding, concurrent and follow-on contractors;

11. Tests, submittal of test reports and acceptance of test results;

12. Planning for phased or total acceptance by Owner; including start up and commissioning;

13. Identification of any manpower, material and equipment restrictions.

14. Sequence of construction to maintain plant operations;

15. Planned outages;

C. The activities included in the Progress Schedule shall be defined in work days. Durations shall be based on the labor (crafts), equipment, and materials required to perform each activity on a normal workday basis. Activity durations shall be 20 working days or less except in the case of non-construction activities such as procurement of materials, delivery of equipment, and concrete curing. All durations shall be the result of definitive manpower and resource planning by Contractor to perform the Work, in consideration of contractually defined on-site work conditions and Contractor's planned means and methods.

D. When the Progress Schedule is accepted by Engineer, Engineer will save a copy of the Progress Schedule as the baseline schedule, and will use it for analysis of Contractor's progress.

E. Contractor shall update the Progress Schedule monthly.

F. The Progress Schedule shall be submitted for review by Owner and Engineer with sufficient time for review and resolution of comments before the period covered by the Preliinary Progess Schedule elapses. At a minimum, the initial Progress Schedule shall be submitted 10 days before the period covered by the Preliminary Progress Schedule elapses.

G. Contractor shall address any Owner and Engineer comments on the initial Progress Schedule and resubmit for review and comments until comments are resolved and the schedule is accepted by Owner and Engineer. Progress payments after the due date for the Progress Schedule submittal will be withheld until the Progress Schedule is accepted by Owner and Engineer.

1.5 ELECTRONIC PROGRESS SCHEDULE FORMAT AND REPORTING.

A. The Progress Schedule shall be created using Primavera P6 scheduling software. Contractor shall use Engineer's file-naming format throughout the project.

1. Electronic schedule files shall be saved with .XML or .XER file extensions.

2. Primavera Project Manager settings for "Baseline Type" shall be used in the following manner:

a. Select <None> as the baseline type for the preliminary Progress Schedule submittal.
b. Once the preliminary and Progress Schedule are accepted, the baseline type shall be named <Initial Plan>.
c. Each subsequent Progress Schedule update shall set the baseline type to <Last Performance Update>.

3. The data date for schedule calculation in the preliminary Progress Schedule and Progress Schedule shall be set as the date of the Notice to Proceed unless otherwise specified by Engineer.

1.6 COST-LOADING.

A. Except for manufacturer lead-time, each Progress Schedule activity that has an actual cost shall have a cost value assigned to it. Equipment or material delivery activities bearing cost shall be separate activities. Each activity's assigned cost shall consist of all costs associated with that activity including all project management, superintendence, overhead and profit costs. The sum of all activity costs shall be equal to the current Contract Price at all times, including approved change orders. Contractor shall certify that the costs are not unbalanced and that the value assigned to each activity represents Contractor's total cost to perform that activity.

B. If Engineer or Owner determines cost data does not meet the requirements for a balanced bid breakdown, Contractor shall submit documentation substantiating any cost allocation questioned. Cost allocations will be considered unbalanced if activity on the Progress Schedule has been assigned a disproportionate allocation of direct costs, overhead and profit. If documentation of the cost data does not, in the opinion of Engineer substantiate cost allocations, the Progress Schedule will be returned to Contractor for action.

C. Unit Price items required to be paid on a unit cost basis as identified in the Bid and the Measurement and Payment section shall be incorporated into the Progress Schedule and measured and updated as specified herein and as specified in the Measurement and Payment section.

D. Contractor shall produce Cash Flow Projection reports and graphics from the Primavera P6 application.

E. Cost-loaded data shall be the basis for monthly payment applications and shall be included with monthly updates of the Progress Schedule.

1.7 RESOURCE-LOADING.

A. Contractor shall build a resource (manpower) library within Primavera P6 and assign resources to each applicable Progress Schedule activity. Resource-loading shall determine the activity duration based on the assigned resource. Contractor shall submit a resource analysis report produced from Primavera P6 in the form of a series of graphics showing the principal trades. The report shall show the number of man-days of effort for each month over the life of the Contract. The manpower requirements forecast shall be updated monthly and shall include the actual manpower used by trade as of the current report period and the manpower required to complete the Work.

1.8 COORDINATING PROGRESS SCHEDULE WITH OTHER CONTRACT SCHEDULES.

A. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Progress Schedule shall be coordinated with the schedules of the other contracts. Owner will provide the schedules of other contracts for preparation and updating of the Progress Schedule. Contractor shall revise the Progress Schedule as required by changes in schedules of other contracts.

B. In case of interference between the operations of different contractors, Owner will determine the work priority of each contractor and the sequence of work necessary to expedite the completion of the entire project. In all such cases, the decision of Owner shall be accepted as final.

1.9 SUBMITTALS.

A. Progress Schedule Submittals

1. The Progress Schedule and associated reports shall be submitted to Engineer for acceptance within the period of the preliminary Progress Schedule specified herein. If the Progress Schedule is not submitted, no progress payments will be made after the due date until the Progress Schedule has been submitted.

2. Printouts and electronic layouts required as part of the Progress Schedule submittal and monthly updates are as follows:

    a. Summary Schedule: one page milestone and summary schedule, sorted by total Float, early-start, early-finish;
    b. Detailed Project Schedule: organized by Work Breakdown Structure (WBS) or area of work; sorted by total Float, early-start, early-finish;
    c. Critical Path Schedule: sorted based on the total Float, early-start, early-finish;
    d. 60-Day Look Ahead Schedule: sorted by total Float, early-start, early-finish;
    e. Activities in Progress: organized by WBS or area of work; sorted by total Float, early-start, early-finish;
    f. Cash Flow Trending Report: presented in an S-Curve format based on original planned early start and late start forecasted expenditures. In addition, the historical actual data point(s) are to be graphed within the S-Curve graphic report;
    g. Monthly payment projections;
    h. Out-of-sequence Report: tabular report showing work performed out-of-sequence.

3. Contractor shall submit additional layouts if directed by Engineer.

4. The submittal shall include the following:

    a. Narrative report summarizing the milestones, critical path, project approach including phasing or use of crews, significant submittal and fabrication items, coordination or interface requirements, Owner-provided items, and list of subcontractors and vendors.
    b. Graphic reports including critical path report (longest path), summary schedule report, total Float report by early-start early-finish, look-ahead report grouped by work breakdown structure or project phasing, and cash flow projection. Cash flow projections include estimated cumulative cost curves based on early and late start dates and projection of monthly payments over the life of the project

5. The schedule, critical path, and look-ahead schedules shall be submitted on E (34”x44”) size paper or 36” wide plots;

6. The Progress Schedule file shall be submitted as an electronic document in PDF (Portable Document Format).

7. The narrative and graphic reports shall be provided on 8”x11” paper and E-size plots respectively.

8. Electronic files shall be submitted in accordance with submittal methods described in the Submittals section.

9. Contractor shall submit three hard copies and one electronic copy of each deliverable.

1.10 MONTHLY SCHEDULE UPDATES.

A. Monthly Progress Schedule updates shall be submitted for the duration of the Contract on a date agreed to by Owner, Engineer, and Contractor. If monthly Progress Schedule updates are not submitted by the due date, progress payments will be withheld until the required information is submitted.

B. The updated schedule shall be reviewed each month in a meeting with Engineer to verify:

1. Actual start dates,

2. Actual completion dates,

3. Activity percent completion,

4. Revised logic (as-built and projected) and changes in activity durations, cost assigned,

5. Cost influence of change orders, if any,

6. Revisions due to extension of time.

C. Prior to each meeting, Contractor shall prepare a complete and accurate report of current procurement and construction progress through the end of the update period, and a depiction of how Contractor plans to continue the Work to meet all contract completion dates. All network changes and status data agreed to during each update meeting shall be considered as accepted by both parties unless written notice of any exceptions is given within five calendar days after the meeting.

D. For major network changes that cannot be agreed to during an updating meeting, Contractor shall submit the proposed changes for Engineer's acceptance prior to inserting such changes into the network. Submittals may be in the form of marked-up networks, fragnets, or schedule abstracts, provided they are submitted with a letter of transmittal. A fragnet is defined as a sequence of new activities and/or activity revisions that are proposed to be added to the existing schedule to demonstrate how project events have an impact on the schedule.

1.11 DATA DATE.

A. The data date is the re-settable date in P6 that serves as the end of a reporting period. The reporting period will be recorded on a monthly basis, e.g., January 1st through January 31st with the 31st as the data date. If required for coordination purposes by Owner, Engineer will provide specific data dates to be used by Contractor.

1.12 REVIEW PROCESS.

A. Engineer will review Contractor's preliminary Progress Schedule and full Progress Schedule submittals within 15 calendar days after receipt of all required information.

B. At the request of Owner or Engineer, Contractor shall participate in any meetings necessary to reach a mutual agreement and acceptance of the preliminary Progress Schedule, Progress Schedules, or Cash Flow Projections.

C. If any of the required submittals are returned to Contractor for corrections or revisions, they shall be resubmitted within ten calendar days after the return mailing date. Resubmittals shall include all information and media included in the first submittal. Review and response by Engineer will be given within 10 calendar days after receipt of each resubmittal.

D. Schedules shall show contract completion of the Work on the Contract completion date and with zero or positive total Float even if Contractor plans to finish early. In no event shall acceptance of the Progress Schedule be a basis for a claim for delay against Owner or Engineer by Contractor for an early finish. A Progress Schedule containing activities with negative Float or that extend beyond the date that the Work is completed and ready for final payment will not be acceptable.

E. Acceptance of the Progress Schedule by Engineer does not relieve Contractor of responsibility for accomplishing the Work by the Contract completion date. Omissions and errors in the accepted Progress Schedule shall not relieve Contractor of obligations under the Contract. Acceptance by Engineer in no way makes Engineer or Owner an ensurer of the Progress Schedule's success or liable for time or cost overruns. Engineer and Owner hereby disclaim any obligation or liability by reason of acceptance of the Progress Schedule by Engineer.

1.13 RESPONSIBILITY FOR SCHEDULE COMPLIANCE.

A. Whenever it becomes apparent from the current Progress Schedule that the critical path is delayed and the contract completion date will not be met, Contractor shall mitigate the delay by taking some or all of the following actions at no additional cost to Owner.

1. Increase construction manpower in such quantities and crafts as will bring the project back on schedule within the completion dates and milestones.

2. Increase the number of working hours per shift, shifts per day, working days per week, and the amount of construction equipment, or any combination of the foregoing, to substantially eliminate the backlog of work.

3. Re-schedule activities to achieve maximum practical concurrence of activities and to comply with the schedule date(s).

B. Within ten calendar days of Engineer's request, Contractor shall submit a recovery schedule and written statement of the steps intended to remove or arrest the delay to the critical path in the schedule. If Contractor fails to submit the required information or should fail to take measures acceptable to Engineer, Engineer with Owner concurrence may direct Contractor to increase man-power, equipment and scheduled work hours to remove or arrest the delay to the critical path and Contractor shall promptly provide such level of effort at no additional cost to Owner.

C. In the event Contractor fails to follow the updated or revised recovery schedule, Owner may elect to withhold progress payments until Contractor complies with the revised schedule.

D. Should Contractor's efforts not remove or arrest the delay to the critical path of the accepted schedule, then Owner shall be entitled to supplement Contractor's work-force and equipment to remove and arrest any delay, and shall be entitled to deduct all costs and expenses associated therewith from payments due to Contractor. If insufficient Contract funds remain, Owner may recover such funds from Contractor and its Surety.

1.14 CHANGES IN THE WORK, DELAYS, AND EXTENSIONS OF TIME.

A. When changes in the Work or delays are experienced by Contractor and Contractor requests an extension of time, Contractor shall submit a written time impact analysis to Engineer illustrating the influence of each change or delay to the current Contract Times. Each time impact analysis shall include a fragnet incorporating the change or delay into the Progress Schedule to demonstrate how Contractor was delayed.

B. Each time impact analysis shall demonstrate the estimated time impact based on the events of the change or the delay; the date the change was given to Contractor or the delay incurred, the status of construction at that point in time, and the event time computation of all activities affected by the change or delay. The event times used in the analysis shall be those included in the latest update of the Progress Schedule or as adjusted for the events of delay.

C. Three copies of the time impact analysis and an electronic copy shall be submitted within seven calendar days of delay occurrence or direction to proceed with a change is given to Contractor. No time extensions will be considered if the time impact analysis is not submitted within the specified time.

D. Engineer will review Contractor's time impact analysis. Contractor shall furnish such justification and supporting evidence as Engineer deems necessary to determine whether Contractor is entitled to an extension of time. Engineer's review of each time impact analysis will be made within five working days of receipt of the time impact analysis and additional information as required by Engineer, unless subsequent meetings and negotiations are necessary.

E. The Contract Times will be adjusted only for causes specified in paragraph 15. Time extensions will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total or remaining Float along the critical path

at the time of actual delay. Delays in activities which are not on the critical path and do not affect Contract Times, will not be considered for an extension of time.

1.15 CAUSES FOR EXTENSIONS OF TIME.

A. Additional positive total Float in the Progress Schedule generated by efficiencies of Owner or Contractor is a shared commodity to be reasonably used by either party, and belongs exclusively to the Project. Contractor is not entitled to any additional compensation for completion of the project prior to expiration of the Contract Times.

B. Owner-Initiated Changes. Owner initiated changes to the Work that absorb Float time will not be considered for an extension of time. Owner-initiated changes that affect the critical path of the Progress Schedule shall be grounds for extending or shortening completion dates. Use of Float time for Contractor initiated changes will require Owner's concurrence. Contractor's changes, however, shall give way to Owner-initiated changes competing for the same Float time.

C. Outside Contractor's Control. Events outside of Contractor's control that affect the critical path of the Progress Schedule will be considered for an extension or reduction of the Contract Times.

D. Weather Delays. Engineer will obtain weather data during construction from a reputable source, and will maintain weather records.

1. Engineer will determine Contractor's entitlement to an extension of the Contract Times as a result of weather delays, based on the flow chart in Figure 1-01 32 16 and the data included in Tables 1, 2 and 3 . Extensions of time will be granted at the discretion of Engineer for circumstances not covered by the flow chart.

2. Any weather-related extension of Contract Times shall be non-compensable. Efficiencies gained as a result of favorable weather within a calendar month, where the number of days of normally anticipated weather days is less than expected, shall contribute to the project Float and shall not affect the Contract Times.

3. Application for a weather related extension of time shall be submitted to Engineer, using form 1-01 32 16**,** and shall state the extension requested and be supported by the relevant weather data.

4. Contractor shall include the number of days, for each calendar period, from Tables 2 and 3 in the Project Schedule. Days shall be labeled as Extreme Weather Float. Extreme Weather Conditions that affect the Critical Path of the Progress Schedule, in excess of the Extreme Weather Float, will be considered for an extension or reduction of the Contract Times. Notification for all extreme weather related events must be submitted no later than 72 hours after the weather impact date.

Table 1

Average Monthly Precipitation

(inches) 10 year average 2016 – 2026 NOAA National Centers for Environmental Information, Annual Climatological Summaries											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.30	6.86	5.88	5.67	6.06	4.74	3.85	5.28	4.62	4.10	3.72	4.79

Table 2 Average Number of Calendar Days with Precipitation of 0.10 Inches or More in a Single 24-hour Period 10 year average 2016 – 2026 NOAA National Centers for Environmental Information, Annual Climatological Summaries											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9	10	8	8	9	9	9	9	5	5	6	7

Table 3 Average Number of Calendar Days with Temperature greater than 90 °F in a Single 24-hour period 10 year average 2016 – 2026 NOAA National Centers for Environmental Information, Annual Climatological Summaries											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	0	0	2	4	3	1	1	0	0

5. Table 3 includes historical weather data for the average number of days recorded where temperature could be considered extreme. Not every day listed in Table 3 will result in an Extreme Weather Condition. A subsequent determination shall be done based on the Heat Index Apparent Temperature or Wind Chill Index.

6. Justification for an extension or reduction of the Contract Times as a result of extreme temperature shall be determined based on the Heat Index Apparent Temperature or Wind Chill Index using formulas below. The Heat Index and Wind

Chill Temperature limits for determining the extreme temperature event shall be those listed in Figure 1-01 32 16.

a. Heat Index:

$$HI = -42.379 + 2.04901523 \times T + 10.14333127 \times RH - 0.22475541 \times T \times RH - 0.00683783 \times T \times T - 0.05481717 \times RH \times RH + 0.00122874 \times T \times T \times RH + 0.00085282 \times T \times RH \times RH - 0.00000199 \times T \times T \times RH \times RH$$

Where:
HI = Heat Index Expressed as an Apparent Temperature in Degrees Fahrenheit (°F)
T = Average Day Temperature in Degrees Fahrenheit (°F)
RH = Average Day Relative Humidity in Percent (%)

If the RH is less than 13% and the temperature is between 80 and 112 degrees Fahrenheit (°F), then the following adjustment is subtracted from HI:

$$ADJUSTMENT = [(13 - RH)/4] \times SQRT\{[17 - ABS(T - 95)]/17\}$$

Where:
HI = Heat Index Expressed as an Apparent Temperature in Degrees Fahrenheit (°F)
T = Average Day Temperature in Degrees Fahrenheit (°F)
RH = Average Day Relative Humidity in Percent (%)
SQRT = Square Root Function

If the RH is greater than 85% and the temperature is between 80 and 87 degrees Fahrenheit (°F), then the following adjustment is added to HI:

$$ADJUSTMENT = [(RH - 85)/10] \times [(87 - T)/5]$$

Where:
HI = Heat Index Expressed as an Apparent Temperature in Degrees Fahrenheit (°F)
T = Average Day Temperature in Degrees Fahrenheit (°F)
RH = Average Day Relative Humidity in Percent (%)

b. Wind Chill Index:

$$WC = 35.74 + 0.6215 \times T - 35.75 \times V^{0.16} + 0.4275 \times T \times V^{0.16}$$

Where:
WC = Wind Chill Index Expressed as a Temperature in Degrees Fahrenheit (°F)
T = Average Day Temperature in Degrees Fahrenheit (°F)
V = Wind Speed in Miles per Hour (mph)

1.16 AS-BUILT SCHEDULE.

A. As a condition precedent to release of final payment, the last update to the Progress Schedule submitted shall be identified by Contractor as the "As-Built Schedule". The "As-Built Schedule" shall reflect the exact manner in which the project was actually constructed (including actual start and completion dates, activities, sequences, and logic) and shall be signed and certified by Contractor's project manager.

1.17 SCHEDULING SOFTWARE APPLICATION.

A. Scheduling software shall be Primavera Project Manager (P6) without exception.

1.18 SCHEDULE SOFTWARE SETTINGS AND RESTRICTIONS

A. Contractor shall consult with Engineer for acceptable Primavera Project Manager software settings and restrictions. The following shall apply unless otherwise directed by Engineer.

1. Schedule Options:

a. Shall be defined only to "Use expected finish dates";
b. Scheduling progressed activities to be set to "Use only retained logic", not progress override option;
c. Critical Path activities defined as total Float less than or equal to zero;
d. Calculating start-to-start lag from "early start" dates; and computing total Float as "finish Float = late finish – early finish";
e. alendar to be set for scheduling relationship lag as "Predecessor Activity Calendar."

2. Activity progress shall be shown using Remaining Duration. Date format shall be DDMMYY.

3. Default activity type shall be set to "Independent Task".

4. Date/time activity constraint(s), other than those required by the Contract, will not be allowed unless accepted by Engineer. Contractor shall identify proposed constraints and explain the constraint purpose in the Narrative Report.

5. Lags shall not be used in the creation of an activity that will perform the same function, e.g., concrete cure time. Lag durations contained in the Progress Schedule shall not have a negative value. Contractor shall identify any lag proposed and explain the purpose of the lag in the Narrative Report.

6. Actual Start and Finish dates shall not be automatically updated by default mechanism that may be included in the CPM scheduling software system. Actual

Start and Actual Finish dates on the CPM schedule shall be updated by actual work progression.

1.19 ACTIVITY CODES.

A. The Primavera (P6) activity codes and work breakdown structure (WBS) to be confirmed or revised by Engineer are listed below. Confirmation or revision of the activity codes and WBS will be provided to Contractor within three workdays of the Effective Date of the Contract. Use of Engineer prescribed activity codes and WBS is mandatory.

B. "Project Codes" as defined by Primavera P6 is reserved for Owner. Only "Activity Codes" at Project Level will be permitted for Contractor use.

Activity Code	Code Value	Description
Phase	0005	Construction Phase
Construction Phase	A	Milestones
	BC	Administrative
	D	Submittals
	E	Construction Activities
		Closeout Phase
Submittals	SUB	Submittals
	R&A	Review & Approve
	F&D	Fabricate & Deliver

Other Codes to be prescribed by Engineer or requested by Contractor for project specific criteria.

1.20 ACTIVITY RELATIONSHIPS

A. Relationships between activities shall be identified with the following information:

1. Predecessor and successor activity ID.

2. Relationship types:

a. FS - Finish to start

b. SS - Start to start
c. FF - Finish to finish
d. SF - Start to finish – This relationship is not allowed, unless authorized by Engineer.

1.21 PROJECT CALENDARS

A. Project Calendars shall use workdays and calendar days as the planning unit for the schedule. Use of Global Calendars is reserved for Owner. Each calendar shall be set to start on Mondays with holidays in accordance with Owner policy. The following calendars shall be used for each activity except as otherwise accepted by Engineer:

1. 5-Day x 8 Hour Workweek (with holidays) shall be used for 5-day 40-hour workweek activities: Monday through Friday. All holidays and non-work days shall be assigned to this calendar. This calendar shall be used for all normal work activities, submittals, and fabricate and delivery activities. This calendar shall be the default calendar for the project unless otherwise specified.

2. 5-Day x 10-Hour Workweek (with holidays) shall be used for 5-day 50-hour workweek activities: Monday through Friday. All holidays and non-work days shall be assigned to this calendar.

3. 6-Day x 10-Hour Workweek (with holidays) shall be used for 6-day 60-hour workweek activities. Monday through Saturday. All holiday and non-work days shall be assigned to this calendar.

4. 7-Day Calendar (no holidays) shall be used for 7-day workweek activities. No non-work days shall be entered into this calendar.

5. Additional Calendars may be assigned depending on need. However, Contractor shall consult with Engineer before other calendars are entered and/or used in the Progress Schedule.

B. The work day to calendar day correlation shall be based on a single shift and 5-day work week with adequate allowance for holidays, adverse weather and all other special requirements of the Work. Contractor may, at his option, propose alternate baseline calendars to allow a second shift and/or a single shift on Saturdays subject to the concurrence and acceptance of Owner. Under no circumstances will a schedule be accepted which allows regularly scheduled work on Sundays.

C. The holidays observed by Owner are as follows:

1. New Year’s Day

2. Memorial Day

3. July 4th

4. Labor Day

5. Thanksgiving Day

6. Christmas Day

1.22 FLOAT

A. Contractor shall not use Float suppression techniques, including preferential sequencing (arranging critical path through activities more susceptible to Owner caused delay); lag logic restraints; zero total or free Float constraints; extended activity times; or imposing constraint dates other than as required by the Contract. Float suppression will be cause for rejection of the preliminary Progress Schedule or full Progress Schedule and its updates.

1.23 MANDATORY MILESTONES

A. The Contract duration shall be equal to the time period between the Notice to Proceed and the completion of the Work in readiness for final payment. The following milestones are mandatory.

1. Notice to Proceed

2. Milestones, if any, as indicated in Contractor's Bid

3. Substantial Completion as indicated in Contractor's Bid

4. Completion and readiness for final payment, as indicated in Contractor's Bid

B. The following additional milestones are to be considered and incorporated into the Progress Schedule in accordance with the Contract, if applicable.

1. Permit constraints

2. Facility shut down or outage milestone requirements

3. Applicable phasing milestones

4. Other milestones deemed appropriate by Engineer

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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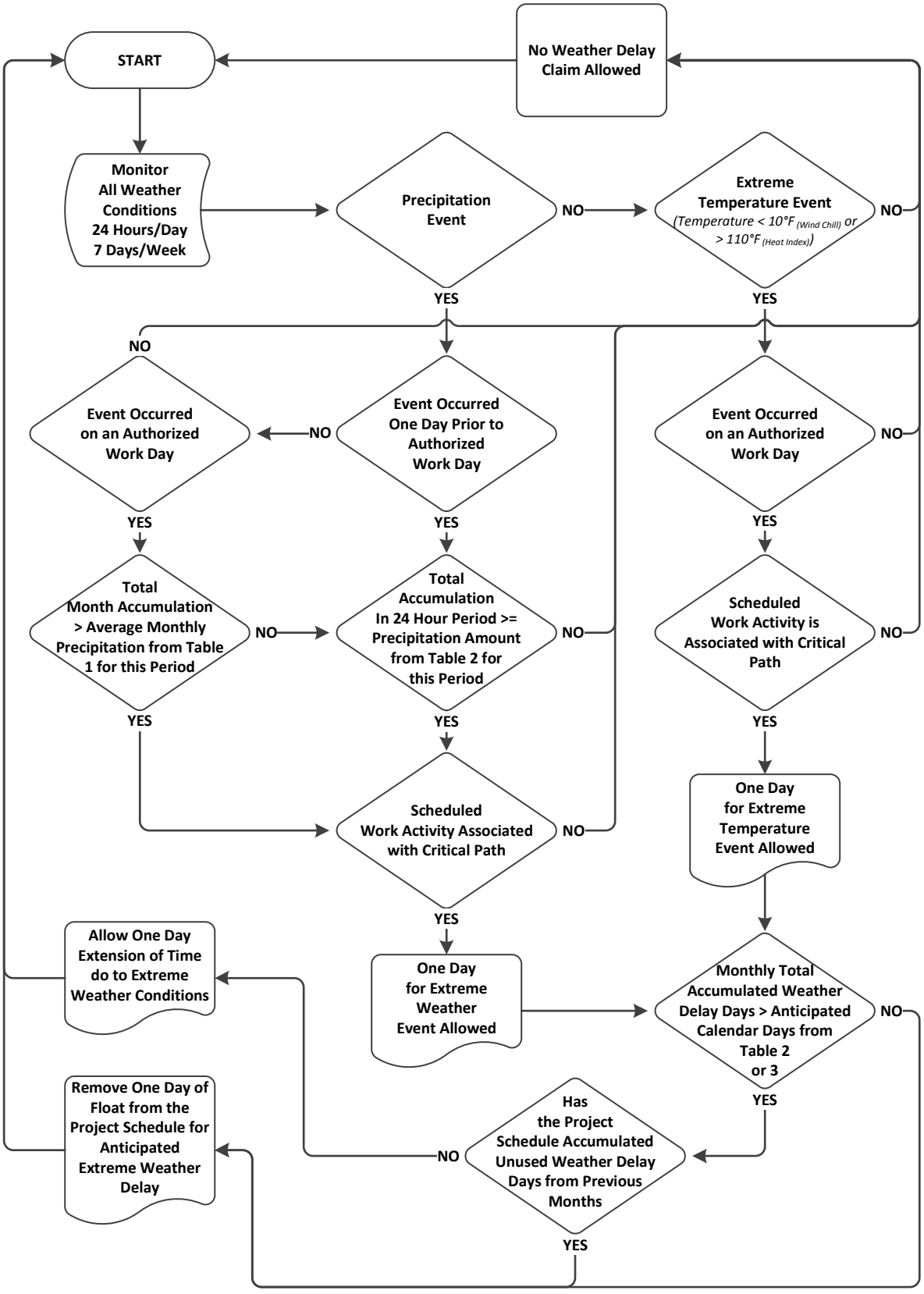

EXTREME WEATHER EVENT DELAY CLAIM DECISION MAKING FLOW CHART

BLACK & VEATCH	*CONSTRUCTION PROGRESS SCHEDULE*	*FIGURE 1-01 32 16*

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Section 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 CONSTRUCTION PHOTOGRAPHS BY CONTRACTOR.

A. Contractor shall be responsible for the production of construction photographs as provided herein. Engineer shall designate the subject of each photograph.

B. For plant projects, photographs of the entire site, or pertinent features thereof, shall be taken before the commencement of Work and promptly submitted to Engineer. The same views shall be rephotographed upon completion of all construction activities and submitted with Contractor's application for final payment. _ _ _ _ additional photographs shall be made each month throughout the progress of the Work at such times as requested by Engineer, and submitted with Contractor's application for progress payment.

C. All photographs shall be color digital, produced by a competent professional photographer. Contractor shall submit the photographs electronically.

D. Engineer will transmit the digital files to Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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Section 01 32 36 - VIDEO MONITORING AND DOCUMENTATION

PART 1 - GENERAL

1.1 VIDEO MONITORING AND DOCUMENTATION BY CONTRACTOR

A. Contractor shall be responsible for the production of pre-construction and construction videos and video documentation as provided herein.

1. Pre-Construction Video Monitoring. For plant projects, pre-construction videos shall be documented by Contractor prior to commencing any work and promptly submitted to Engineer. Videos of the same views shall be produced upon completion of all construction activities and submitted with Contractor's application for final payment. Pre-construction videos shall include the following areas:

    a. List areas to be covered by videos
    b. Videos shall be submitted in MPEG format with a minimum video resolution of 12 megapixels. Video submittals shall be made in accordance with the Submittals Section. In addition to project information required by the Submittals Section, each video submittal shall include the following additional information:
        1) Date video was taken
        2) Text description of area where video was taken, including vantage point, direction of view and elevation of camera
        3) Text or audio description of purpose of video
        4) Text or audio narration of extents and content of video

2. Periodic Construction Progress Video Monitoring. Periodic progress videos shall be made by Contractor each month throughout the progress of the Work at such times as requested by Engineer, and submitted with Contractor's application for progress payment. Progress videos shall cover the following areas:

    a. List areas to be covered by videos
    b. Videos shall be submitted in MPEG format with a minimum video resolution of 12 megapixels. Video submittals shall be made in accordance with the Submittals Section. In addition to project information required by the Submittals Section, each video submittal shall include the following additional information:
        1) Date video was taken
        2) Text description of area where video was taken, including vantage point, direction of view and elevation of camera

3) Text or audio description of purpose of video
4) Text or audio narration of extents and content of video

3. Drone Based Video Monitoring. Contractor shall produce aerial drone based video monitoring for the locations and conditions indicated below. Minimum camera resolution shall be 12 megapixels. Contractor shall utilize drones and drone operators with all proper certifications and licenses for both federal and local jurisdictions. Drone based videos shall be as indicated below:

   a. List drone videos required and frequency of repetition if applicable

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SUBMITTAL No. _____

SPECIFICATION SECTION _____

Do not combine multiple sections together unless required by specifications.

(Contractor's Letterhead)

SUBMITTAL IDENTIFICATION & CONTRACTOR'S APPROVAL STATEMENT

General Information

Date:	**Copies:**	**Drawing Ref:**
Description:		
Location:		
Manufacturer(s):		
Subcontractor or Supplier:		
Remarks:		

Contract Document Cross-Reference and Deviation Table (add rows as needed)

Specification Paragraph Reference	Submittal Page Ref	Compliant (Y/N)	Deviation Explanation (if applicable)

CONTRACTOR'S APPROVAL

(Contractor) has reviewed and coordinated the submitted documentation and verifies that the equipment and material meet the requirements of the Work and the Contract Documents. We accept sole responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data contained in the submittal as required by the Contract Documents.

Deviations: □ None □ Yes (Noted in Table above)

Approved By: _____ Date: _____

This approval does not release Contractor from the contractual responsibilities.

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SHOP DRAWINGS AND ENGINEERING DATA.

A. General.

1. The Project has been designed by Consulting Engineer and Consulting Engineer will perform design-intent reviews of submittals. Owner, Consulting Engineer, Engineer, and Contractor may develop a protocol for the transmittal of shop drawings, samples, and other submittals.

2. Shop Drawings and engineering data (submittals) covering all equipment and all fabricated components and building materials which will become a permanent part of the Work under this Contract shall be submitted to Engineer for review, as required. Submittals shall verify compliance with the Contract Documents, and shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and the operation of component materials and devices; the external connections, anchorages, and supports required; the performance characteristics; and dimensions needed for installation and correlation with other materials and equipment.

3. A preliminary schedule of submittals shall be submitted by Contractor in accordance with the Supplementary Conditions.

4. Contractor shall maintain the submittal list for reporting and tracking purposes and shall provide a monthly submittal status showing the following minimum information:

   a. Overall completion percentage of submittals (completed submittals defined as having been submitted and reviewed with review status that does not require additional submittal or resubmittal)
   b. Planned completion percentage, based on initial submittal list/plan.
   c. Late submittals (Contractor’s ball-in-court)
   d. Late submittals (Owner/Engineer’s ball-in-court)
   e. Submittals planned for coming month

5. Each submittal shall cover items from only one section of the specification unless the item consists of components from several sources. Contractor shall submit a complete initial submittal including all components. When an item consists of components from several sources, Contractor's initial submittal shall be complete including all components.

6. All submittals, regardless of origin, shall be approved by Contractor and clearly identified with the name and number of this Contract, Contractor's name, and

references to applicable specification paragraphs and Contract Drawings. Each copy of all submittals, regardless of origin, shall be stamped or affixed with an approval statement of Contractor. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

7. Contractor shall submit a Submittal Identification & Contractor's Approval Statement with each submittal (per Figure 01 33 00 F1). Contractor shall be solely responsible for the completeness of each submittal. The Contract Document Cross-Reference and Deviation Table shall be filled out for each submittal as follows:

   a. Specification Paragraph Reference. List each relevant paragraph from the specification (if submittal is for an item on a drawing, list the drawing number).
   b. Submittal Page Ref. List the page number(s) in the Contractor's submittal where the referenced specification paragraph requirements are addressed.
   c. Compliant (Y/N). If the submittal is compliant with the specification requirements for the indicated specification paragraph number, select Y. Otherwise select N, indicating a deviation from the specification requirements.
   d. Deviation Explanation. If N was selected for the Compliant column, describe the deviation in sufficient detail to allow review and consideration by Engineer.

8. Contractor's stamp or affixed approval statement of a submittal, is a representation to Owner and Engineer that Contractor accepts sole responsibility for determining and verifying all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto, and that Contractor has reviewed and coordinated each submittal with other Shop Drawings and with the requirements of the Work and the Contract Documents.

9. All deviations from the requirements of the Contract Documents shall be identified as deviations on each submittal and shall be tabulated in the table provided on the Submittal Identification & Contractor's Approval Statement. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

10. Contractor shall submit shop drawings electronically. Submittals made by any other method will be returned without review.

11. Drawings and the necessary data shall be submitted electronically to Engineer as specified below. Submittal documents shall be in color to facilitate use of red line markups.

a. All electronic files shall be in Portable Document Format (PDF) as generated by Adobe Acrobat Professional.
b. The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated. PDF images must be at a readable resolution.
c. Documents should be scanned or generated at 300 dots per inch (dpi). Use of higher resolution is acceptable with Owner and Engineer approval.
d. Optical Character Recognition (OCR) capture must be performed on these images so that text can be searched, selected and copied from the generated PDF file.
e. The PDF documents shall have a bookmark created in the navigation frame for each major entry ("Section" or "Chapter") in the Table of Contents.
f. Thumbnails shall be generated for each page or graphic in the PDF file.
g. The opening view for each PDF document shall be as follows:
    1) Initial View: Bookmarks and Page
    2) Magnification: Fit In Window
    3) The file shall open to Contractor's transmittal letter, with bookmarks to the left. The first bookmark shall be linked to the Table of Contents.

h. PDF document properties shall include the submittal number for the document title and Contractor's name for the author.
i. When multiple files are required for a submittal the least number of files possible shall be created.

12. Contractor shall post submittals and retrieve Engineer's submittal review comments through the Project website accessible through the Internet. Instruction on procedures for posting and retrieving submittals will be provided after award of the Contract.

13. Facsimiles (fax) will not be acceptable. Submittals will not be accepted from anyone but Contractor. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.

B. Engineer's Review of Submittals.

1. Engineer's review of submittals covers only general conformity to the Drawings and Specifications, external connections, and dimensions that affect the layout; it does not indicate thorough review of all dimensions, quantities, and details of the material, equipment, device, or item covered. Engineer's review shall not relieve Contractor of sole responsibility for errors, omissions, or deviations in the drawings and data, nor of Contractor's sole responsibility for compliance with the Contract Documents.

2. Engineer's submittal review period shall be 28 consecutive calendar days and shall commence on the first calendar day following receipt of the submittal or resubmittal in Engineer's office.

3. When the drawings and data are returned with review status "NOT ACCEPTABLE" or "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer .

   a. If submittals are made in hard copy, five corrected copies shall be resubmitted.
   b. If submittals are made electronically, the corrected drawings and data shall be resubmitted through the Project website.
   c. Resubmittals by facsimile or e-mail will not be accepted. When the drawings and data are returned with review status "EXCEPTIONS NOTED", "NO EXCEPTIONS NOTED", or "RECORD COPY", no additional copies need be furnished unless specifically requested by Engineer .

C. Resubmittal of Shop Drawings and Data.

1. Contractor shall accept full responsibility for the completeness of each resubmittal. Contractor shall verify that all corrected data and additional information previously requested by Engineer are provided on the resubmittal. Resubmittals shall be in an organized and consistent format.

2. When corrected copies are resubmitted, Contractor shall direct specific attention to all revisions in writing and shall list separately any revisions made other than those called for by Engineer on previous submittals. Requirements specified for initial submittals shall also apply to resubmittals. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) or a unique identification that indicates the initial submittal and correct sequence of each resubmittal.

3. If more than one resubmittal is required because of failure of Contractor to provide all previously requested corrected data or additional information, Contractor shall reimburse Owner for the charges of Engineer for review of the additional resubmittals. This does not include initial submittal data such as shop tests and field tests that are submitted after initial submittal.

4. Resubmittals shall be made within 30 days of the date of the letter returning the material to be modified or corrected, unless within 14 days Contractor submits an acceptable request for an extension of the stipulated time period, listing the reasons the resubmittal cannot be completed within that time.

5. The need for more than one resubmittal, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Times unless delay of the Work is the direct result of a

change in the Work authorized by a Change Order or failure of Engineer to review and return any submittal to Contractor within the specified review period.

D. Color Selection.

1. Contractor shall submit samples of colors and finishes for all accepted products before Engineer will coordinate the selection of colors and finishes with Owner. Engineer will prepare a schedule of finishes that includes the colors and finishes selected for both manufactured products and for surfaces to be field painted or finished and will furnish this schedule to Contractor within 60 days after the date of acceptance of the last color or finish sample.

1.2 OPERATION AND MAINTENANCE DATA AND MANUALS.

A. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment Supplier shall prepare a Project specific operation and maintenance manual for each type of equipment indicated in the individual equipment sections or the equipment schedule.

B. Unless otherwise agreed by Engineer , the operation and maintenance manual for each type of equipment shall only be submitted for review following completion of review of all shop drawings and engineering data pertaining to that equipment.

C. Parts lists and operating and maintenance instructions shall be furnished for other equipment not listed in the individual equipment sections or the equipment schedule.

D. Operation and maintenance manuals shall include the following:

1. Equipment function, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, adjustment, and checking instructions.

3. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

4. Lubrication and maintenance instructions.

5. Guide to troubleshooting.

6. Parts lists and predicted life of parts subject to wear.

7. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

8. Test data and performance curves, where applicable.

E. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by Contractor.

F. Hard copy and Electronic Manuals

1. Three hard copies and one electronic copy of each manual shall be submitted to Engineer prior to the date of shipment of the equipment.

2. When the O&M manuals are returned with the review status "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer , and two copies of the corrected portion(s) and one complete corrected copy of the O&M manual returned to Engineer.

3. After review by Engineer is complete, three hard copies and one electronic copy of each operation and maintenance manual shall be prepared and delivered to Engineer not later than 30 days prior to placing the equipment in operation.

4. The electronic copy shall be submitted through the Project website, and will be reviewed for content and organization and assigned a review status by Engineer . When corrections are required, a corrected version of the electronic copy shall be resubmitted.

5. Procedures for submission of the electronic copy will be provided after award of the Contract.

6. The completed O&M manual shall also be filed to the Project website.

G. Electronic Manuals

1. Manuals shall be submitted in electronic format to Engineer prior to the date of shipment of the equipment. The manuals shall be submitted and Engineer's review comments retrieved, through the Project website accessible through the Internet. Instruction on procedures for posting and retrieving O&M submittals and review comments will be provided after award of the Contract. When the O&M manuals are returned with the review status "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer , and corrected manuals resubmitted to Engineer. When review by Engineer is complete, three copies of each electronic O&M manual shall be delivered. Delivery of the final O&M shall be made 30 days prior to placing the equipment in operation.

H. All material shall be marked with Project identification, and inapplicable information shall be marked out or deleted.

I. Shipment of equipment will not be considered complete until all required manuals and data have been received.

J. Hard Copy Operation and Maintenance Manual Requirements.

1. Hard copies submitted for review shall be temporarily bound in heavy paper covers bearing suitable identification. All manuals and other data shall be

printed on heavy, first quality 8-1/2 x 11 inch paper, with standard three-hole punching. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches .

2. Where reduction is not practicable, larger drawings shall be folded separately and placed in envelopes, which are bound into the manuals. Each envelope shall be suitably identified on the outside.

3. Each volume containing data for three or more items of equipment shall include a table of contents and index tabs.

4. The final hard copy of each manual shall be prepared and delivered [in substantial, permanent, three-ring or three-post binders][in heavy paper covers] with a table of contents and suitable index tabs.

K. Electronic Operation and Maintenance Manual Requirements.

1. Electronic manuals shall be in Adobe Acrobat's Portable Document Format (PDF), and shall be prepared at a resolution between 300 and 600 dots per inch (dpi), depending on document type.

2. Optical Character Recognition (OCR) capture shall be performed on these documents. OCR settings shall be performed with the "original image with hidden text" option in Adobe Acrobat Exchange.

3. File size shall be limited to 10 MB. A single PDF file greater than 10 MB may only be submitted if acceptable to Owner. When multiple files are required the least number of files possible shall be created.

4. File names shall be in the format OMXXXXX-YYYZ-V.pdf, where XXXXX is the five digit number corresponding to the specification section, YYY is a three digit O&M manual number, e.g. 001, Z is the letter signifying a resubmittal, A, B, C, etc., and V is a number used only when more than one 10 MB file is required for an O&M manual.

5. Documents prepared in PDF format shall be processed as follows:

   a. Pages shall be searchable (processed for optical character recognition) and indexed when multiple files are required.
   b. Pages shall be rotated for viewing in proper orientation.
   c. A bookmark shall be provided in the navigation frame for each entry in the Table of Contents.
   d. Embedded thumbnails shall be generated for each completed PDF file.
   e. The opening view for PDF files shall be as follows:
      1) Initial View: Bookmarks and Page
      2) Page Number: Title Page (usually Page 1)
      3) Magnification: Set to Fit in Window
      4) Page: Single Page

f. Where the bookmark structure is longer than one page the bookmarks shall be collapsed to show the chapter headings only.
g. When multiple files are required the first file of the series (the parent file) shall list every major topic in the Table of Contents. The parent file shall also include minor headings bookmarked based on the Table of Contents. Major headings, whose content is contained in subsequent files (children) shall be linked to be called from the parent to the specific location in the child file. The child file shall contain bookmark entries for both major and minor headings contained in the child file. The first bookmark of any child file shall link back to the parent file and shall read as follows "Return to the *Equipment Name* Table of Contents", e.g. Return to the Polymer Feed System Table of Contents.
h. Drawings shall be bookmarked individually.
i. Files shall be delivered without security settings to permit editing, insertion and deletion of material to update the manual provided by the manufacturer.

L. Labeling

1. As a minimum, the following information shall be included on all final O&M manual materials, jewel cases, electronic and hard copy manuals:

a. Equipment name and/or O&M title spelled out in complete words.
b. Project Name.
c. Owner Project/Contract Number.
d. Specification Section Number. Example: “Section 15500”
e. Manufacturer’s name.
f. File Name and Date.

2. Label example:

Backwash Pump Operation and Maintenance Manual

Somewhere Plant Expansion

Project/Contract No. ____

Specification Section 11110

Manufacturer

OM11110-001.pdf, 5/05/07

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

Section 01 42 13 - ABBREVIATIONS AND ACRONYMS

PART 1 - GENERAL

1.1 LIST OF ABBREVIATIONS.

A. Abbreviations for standards and organizations used in the Contract Documents are defined as follows:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies
AFBMA	Antifriction Bearing Manufacturers Association now recognized as the ABMA
AFPA	American Forest & Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association International

ANSI	American National Standards Institute
APA	Engineered Wood Association (formerly American Plywood Association)
API	American Petroleum Institute
AREMA	American Railway Engineers and Maintenance-of-Way Association
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International
AWG	American Wire Gauge
AWI	Architectural Woodwork Institute
AWPA	American Wood-Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America (formerly SCPI)
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute

CS	Commercial Standard (U.S. Department of Commerce)
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EEI	Edison Electric Institute
EJCDC	Engineers' Joint Contract Documents Committee
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
Fed Spec	Federal Specification
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	Factory Mutual
FSA	Fluid Sealing Association
HEI	Heat Exchange Institute
HMI	Hoist Manufacturers Institute
HPMA	Hardwood Plywood Manufacturers Association
HTI	Hand Tools Institute
I-B-R	Institute of Boiler and Radiator Manufacturers
IEEE	Institute of Electrical and Electronics Engineers

IBC	International Building Code
IES	Illuminating Engineering Society
IFI	Industrial Fasteners Institute
IPCEA	Insulated Power Cable Engineers Association
IRI	Industrial Risk Insurers
ISA	International Society of Automation
LEED	Leadership in Energy and Environmental Design
MHI	Materials Handling Institute
MIL	Military Specification
MMA	Monorail Manufacturers Association
MSS	Manufacturers Standardization Society of Valve and Fitting Industry
NAAMM	National Association of Architectural Metals Manufacturers
NACE	NACE International
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NBS	See NIST
NCSPA	National Corrugated Steel Pipe Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEII	National Elevator Industry, Inc.
NEMA	National Electrical Manufacturers Association

NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology (formerly NBS)
NLA	National Lime Association
NPC	National Plumbing Code
NPT	National Pipe Thread
NRMCA	National Ready Mixed Concrete Association
NSC	National Safety Council
NSF	NSF International (formerly National Sanitation Foundation)
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PS	Product Standard
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Door Institute
SFPA	Southern Forest Products Association
SI	Systéme International des Unités (International System of Units)
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute

SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricators Association
SPI	Society of the Plastics Industry
SPTA	Southern Pressure Treaters Association
SSFI	Scaffolding, Shoring & Forming Institute, Inc
SSPC	SSPC: The Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
UL	Underwriters' Laboratories
USBR	U.S. Bureau of Reclamation
USGBC	U.S. Green Building Council
WEF	Water Environment Federation

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01 45 00 - QUALITY CONTROL

Section 01400 - QUALITY CONTROL - LIST OF SUBJECTS

1. TESTING SERVICES

1.01. Testing Services Provided by Contractor

1.02. Testing Services and Special Inspections Provided by Owner

1.03. Transmittal of Test Reports

2. OFFSITE INSPECTION

3. MANUFACTURER'S FIELD SERVICES

3.01. Services Furnished Under This Contract

3.02. Services Furnished by Others

SECTION 01 45 00 - QUALITY CONTROL

PART 1 - GENERAL

1.1 TESTING SERVICES.

A. Testing services shall be provided in accordance with Paragraph 14.02 of the General Conditions. All tests to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to Engineer and/or Authority Having Jurisdiction excluding testing as specified to be conducted directly by Contractor. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards.

B. Testing services provided by Owner are for the sole benefit of Owner and/or as required by the governing building code; however, test results shall be available to Contractor. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.

C. Testing Services Provided by Contractor.

1. Unless otherwise specified, Contractor shall provide all testing services in connection with the following:

a. Any Work or part thereof specifically to be inspected, tested or approved by an employee or representative of an Authority Having Jurisdiction. Contractor shall assume full responsibility for arranging and obtaining such inspections, tests or approvals. Contractor shall pay all costs associated for these activities and shall provide the required certificates of inspection or approval.
b. Any inspections, tests or approvals required for Owner or Engineer acceptance of materials or equipment to be incorporated in the Work. This includes any items required for acceptance of materials, concrete mix designs or equipment submitted for approval prior to Contractor’s purchase for incorporation in the Work.
c. Testing, adjusting and balancing of mechanical, electrical and other equipment and systems as specified to be incorporated into the Work. This includes services required by manufacturers of equipment or other products such as concrete repair products, pipe, coatings, linings and roof membranes furnished under the Contract Documents.
d. Tightness testing of containment structures and pressure or leakage testing of piping as specified.
e. Any Work (or part thereof) required by the Contract Documents to be approved by Owner, Engineer or other designated individual or entity. Contractor shall assume full responsibility for arranging and obtaining

such approvals, pay all costs in connection therewith and submit to Engineer the required certificates of approval.

2. Excluding those conducted directly by an Authority Having Jurisdiction or expressly specified to be conducted directly by Contractor, inspections and tests shall be performed by independent inspectors, approved agencies or other qualified individuals or entities acceptable to Owner and Engineer .

D. Testing Services and Special Inspections Provided by Owner.

1. Unless otherwise specified, Owner shall employ and pay for the services of an independent testing laboratory, approved agency or other qualified individual or entities for inspections, tests or approvals required by the Contract Documents for field quality control. These include items indicated as Owner provided in the following specifications:

a. Structural Tests and Special Inspections
b. Excavation and Fill for Structures
c. Trenching and Backfilling
d. Concrete Paving
e. Concrete Culverts
f. Cleaning and Disinfection of Water Pipelines
g. Concrete
h. Lightweight Structural Concrete
i. Reservoir Shotcrete
j. Mass Concrete
k. Masonry
l. Steel Joist Framing
m. Anchorage in Concrete and Masonry
n. Structural and Miscellaneous Metals
o. Fluid Applied Deck Coverings
p. Filter Underdrains and Media
q. Steel Pipe
r. Other materials and equipment at the discretion of Owner.

E. Contractor shall provide access to the site and Work in accordance with 14.01 and 14.02 of the General Conditions. Contractor shall give timely notice of the readiness of the Work for inspection, tests or approvals and shall cooperate with the inspection and testing personnel to facilitate the required tests and inspections. Contractor shall furnish all sample materials and cooperate in the testing activities, including sampling. Contractor shall interrupt the Work when necessary to allow testing, including sampling, to be performed. Contractor shall have no Claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by Engineer or Agency personnel, Contractor shall furnish personnel and facilities to assist in the activities as required.

F. Transmittal of Test Reports.

1. Written reports of tests and engineering data furnished by Contractor for Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.

2. The Approved Agency retained by Owner will furnish [five] copies of a written report of each test. Two copies of each test report will be transmitted to the Resident Project Representative, one copy to the Special Inspector, one copy to Engineer, and one copy to Contractor, within 3 days after each test is completed or as directed by the Statement of Special Inspections as applicable.

1.2 OFFSITE INSPECTION.

A. Inspection of materials or equipment during the production, manufacturing, or fabricating process, or before shipment, will be performed by Engineer or an independent testing firm or Approved Agency acceptable to Engineer and Authority Having Jurisdiction as specified in the materials and equipment sections or Structural Tests and Special Inspections section.

B. Except as otherwise specified in other sections, Contractor shall give appropriate written notice to Engineer not less than 10 days before offsite inspection services are required, and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to cooperate with inspecting personnel in the performance of their duties.

C. The inspection organization will submit a written report to Engineer , with a copy to Contractor, at least once each week or as directed by the Statement of Special Inspections as applicable.

(Optional Paragraph)

1.3 MANUFACTURER'S FIELD SERVICES

A. Manufacturer’s field services shall be as specified herein except as specifically specified in the respective equipment sections.

B. Services Furnished Under This Contract. An experienced, competent, and authorized representative of the manufacturer of each item of equipment for which field services are indicated in the respective equipment section or in the equipment schedule section shall visit the Site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer .

C. Each manufacturer's representative shall furnish to Owner, through Engineer , a written report certifying that the equipment has been properly installed and lubricated; is in

accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

D. All costs for these services shall be included in the Contract Price.

1.4 Services Furnished by Others.

A. Contractors furnishing materials and equipment under separate contract for installation under this Contract shall furnish field representatives to instruct and guide Contractor during the installation operations.

B. Such services shall be furnished at no charge to Contractor for the number of days and round trips to the Site indicated below. Any additional services in connection with installation that are required by reason of Contractor's progress shall be paid for by Contractor.

Contract No. and Title	Type of Material or Equipment	Limits of Services Furnished at No Charge	
		Days	Round Trips

C. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services furnished by others.

D. Contractor shall perform no Work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and Contractor furnishing such materials or equipment concur otherwise.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01 45 33 - CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1.1 SCOPE

A. This specification is intended to assist Owner and Contractor in implementing a special inspections and testing program as described in the building code, and to inform Owner and Contractor and its Suppliers of their code required responsibilities.

B. Owner, or their agent, will engage one or more Approved Agencies to conduct tests and special inspections specified in this section and other related sections. The Approved Agency shall not be employed by Contractor or a supplier materially participating in the project.

C. Contractor shall not be responsible for performing the inspections and testing required in this section. Contractor's responsibilities are primarily in a supporting role, and shall be as described herein.

1.2 GENERAL

A. Structural testing and special inspection services are required to verify compliance with the Contract Documents. These services do not relieve Contractor of responsibility for compliance with the Contract Documents.

B. Specific quality-assurance and quality-control requirements for individual construction activities are also referenced in other specification sections. Requirements in those sections may also cover production of standard products.

1.3 DEFINITIONS

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests, furnishing inspection services, or furnishing product certification when such agency has been approved by the Authority Having Jurisdiction.

B. Approved Fabricator: An established and qualified person, firm or corporation approved by the Authority Having Jurisdiction to perform work without Special Inspection.

C. Authority Having Jurisdiction (AHJ): The officer or other designated authority charged with the administration and enforcement of the building code, or a duly authorized representative. Also commonly known as the Building Official.

D. Contract Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project

necessary for obtaining a building permit. Contract Documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the Registered Design Professional beyond those issued for a building permit.

E. Pre-Engineered Structural Elements: Structural elements specified by the Registered Design Professional but which may be designed by another Registered Design Professional. (Examples are items such as open web steel joists and joist girders, metal joists, pre-cast concrete elements, pre-fabricated metal buildings, pre-stressed wire wrapped tanks, tilt-up concrete panel reinforcement and lifting hardware.)

F. Registered Design Professional (RDP): 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.

G. Registered Design Professional in Responsible Charge (RDPRC): A Registered Design Professional engaged by Owner to review and coordinate certain aspects of the project, as determined by the AHJ and Contract Documents, for compatibility with the design of the buildings or structure, including submittal documents prepared by others, deferred submittal documents and phased submittal documents.

H. Submittal Documents: Written, graphic and pictorial documents prepared and / or assembled by Contractor or Supplier based on the Contract Documents.

I. Special Inspection: Inspection and/or testing required by the governing building code, as amended by the AHJ, of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.

J. Special Inspector: A qualified person demonstrating competence, to the satisfaction of the AHJ and RDPRC, for inspection of the particular type of construction or operation requiring special inspection. The Special Inspector will be qualified as specified herein.

K. Testing Agency: A qualified materials testing laboratory under the responsible charge of a Registered Design Professional, approved by the AHJ and the RDPRC, to measure, examine, test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with Contract Documents.

1.4 INSPECTION AND TESTING AGENCY QUALIFICATIONS.

A. The qualifications of all personnel performing special inspection and testing activities will be as required by the applicable building code. Selection of individual inspectors and testing technicians will be subject to the approval of the AHJ and RDPRC.

B. Structural Steel Testing Agency Requirements. Submit the following to the RDPRC and the AHJ prior to beginning testing:

1. Written practices for monitoring and control of the inspection and testing agency operations including:

    a. Inspection and testing agency's procedures for the selection and administration of inspection personnel, describing the training, experience, and examination requirements for qualification and certification of inspection personnel.
    b. Inspection and testing agency's inspection procedures, including general inspection, material controls, and visual welding inspection.

2. Qualifications of management and quality assurance personnel designated for the project.

3. Qualification records for inspectors and NDT technicians designated for the project.

4. NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

1.5 CONFLICTING REQUIREMENTS, REPORTS AND TEST RESULTS

A. Precedence.

1. The Approved Agency reports and testing results shall have precedence over reports and test results provided by Contractor.

1.6 ATTACHMENTS

A. The following attachments are included for use by Contractor and the Approved Agency. The AHJ may have similar documents that can be used in lieu of these forms.

Attachment		Notes
Appendix A – Forms for Use by Contractor and Fabricators		
	Contractor's Statement of Responsibility	To completed by Contractor and relevant suppliers and submitted to Owner and AHJ.
	Fabricator's Certificate of Compliance	To be completed by Contractor's Approved Fabricators who perform work without special inspections, and submitted to AHJ and RDPRC prior to placement of the fabricated items in the work.

Appendix B – Forms for Use by Approved Agency		Appendix B shall not be considered as part of these Contract Documents. It is provided for Contractor's reference, and for benefit of Owner and AHJ.
	Request for Approval of Individual Inspector or Technician	To be completed by Approved Agency. Approved Agency will submit the form to the AHJ and RDPRC for their approval of individual inspectors and testing technicians.
	Final Report of Special Inspections	To be completed and sealed by Approved Agency. Approved Agency or Owner will submit to AHJ at the completion of construction.
Appendix C – Statement of Special Inspections		Appendix C shall not be considered as part of these Contract Documents. It is provided for Contractor's reference, and to fulfill the code requirements of listing the required inspection program in the construction documents. The Statement of Special Inspections shown in Appendix C is in draft form, and will be fully completed jointly by the RDPRC and the Approved Agency. The RDPRC will seal the Statement of Special Inspections after completion and Contractor or Owner shall submit the completed form to the AHJ as part of the building permit application process.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONTRACTOR AND FABRICATOR RESPONSIBILITIES.

A. Each Fabricator or Contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, seismic resisting component, main wind force-resisting system, or a wind-resisting component listed in the SSI shall submit a "Contractor's Statement of Responsibility" to the AHJ and to Owner prior to the commencement of work.

B. To be considered an Approved Fabricator that may perform work without Special Inspection, the Fabricator shall submit copies of certifications from the International Accreditation Service (IAS) or other recognized and acceptable accreditation organization a minimum of 30 days prior to the start of fabrication. Acceptance as an Approved Fabricator is subject to approval by the AHJ. If the project specifications required an Approved Fabricator, and the AHJ does not accept the Fabricator as an Approved Fabricator, special inspection may become necessary in

the Fabricator's shop. Such inspections will be performed by Approved Agency and Contractor shall reimburse Owner for the cost for the inspections.

C. Contractor shall provide, from each Approved Fabricator, a "Fabricator's Certificate of Compliance" indicating that the work was performed in accordance with the approved Contract Documents. The certificate(s) shall be submitted to the AHJ and the RDPRC prior to placement of the fabricated items into the work.

D. Contractor shall assist in coordination of the inspection and testing services with the progress of the work. Contractor shall provide sufficient notice to allow proper scheduling of all inspection and testing personnel. Contractor shall provide access to inspection and testing personnel and shall ensure that all work requiring special inspection is not concealed prior to the completion of the inspection and/or testing.

E. Contractor shall submit schedules to Owner, RDPRC and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring tests and special inspections.

F. Contractor shall provide the Special Inspector access to approved plans at the job site or fabrication shop as applicable.

G. Contractor shall retain at the job site or fabrication shop, as applicable, all special inspection records submitted by an Approved Agency or Special Inspector and shall provide these records for review by the AHJ's inspector upon request.

H. Contractor shall repair and/or replace work that does not meet the requirements of the Contract Documents.

3.2 APPROVED AGENCY AND SPECIAL INSPECTOR RESPONSIBILITIES.

A. Preliminary Approval of Special Inspectors and Testing Technicians

1. The Approved Agency will submit a "Request for Approval of Individual Inspector or Technician" form to the AHJ and RDPRC for each proposed Special Inspector or testing technician. The form will include the individual's credentials, which as a minimum will meet the requirements indicated in this section. The AHJ may have additional requirements to those specified herein. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

B. Perform Inspections and Tests

1. Be present for and perform continuous or periodic inspections and tests as listed in the SSI for conformance of the work to the AHJ approved Contract Documents. Notify Contractor personnel of their presence and responsibilities. When the SSI column titled "Other Code, Standard or Reference" indicates "Manufacturer's research reports", inspector will obtain the most current ICBO-ES Report, ICC-ES Legacy Report, ICC-ES Report, or IAPMO

UES Evaluation Report (as applicable) prior to the applicable inspection, for inspection requirements related to the type and brand of products or materials being inspected.

2. Provide additional inspections and testing as necessary to determine compliance with the Contract Documents. Perform special inspections in a timely manner to avoid delay of work.

3. The Approved Agency will be responsible to insure that all inspection or testing activity, whether performed locally or at off-site fabrication facilities, fully complies with this section and the SSI.

C. Interim Inspection Reports

1. Furnish interim inspection reports to the AHJ, the RDPRC, Contractor, Engineer, and Owner during the progress of the work. Frequency of reports will be as established in the SSI. Reports will indicate that work inspected was done in conformance to the approved Contract Documents, or that the work was defective, as applicable.

2. Special inspection reports and test results will include, but not be limited to, the following:

   a. Project name and address.
   b. Permit number.
   c. Special Inspection Agency name, address, and phone number.
   d. Unique identification of the report and of each page.
   e. Date and time of inspection.
   f. Description of inspections or tests performed, including item description and location (reference grid lines, floors, elevations, etc.). Identify approved agencies employed to carry out tests.
   g. Identification of test/inspection equipment used.
   h. Statement noting that the work, material, and/or product conforms or does not conform to the construction document requirements. Describe defective items.
   i. Name and signature of Contractor's representative who was notified of work, material, and/or products that do not meet the construction document requirements.
   j. Name and signature of Special Inspector and/or testing agency representative performing the work.

D. Report of Defective Work

1. Each agent will maintain a log that identifies work that does not meet the requirements of the Contract Documents. Include:

   a. Description and exact location.
   b. Reference to applicable drawings and specifications.
   c. Reference to original inspection/test report and subsequent dates of re-inspection/retesting.
   d. Name and title of each individual notified and method of notification.
   e. How defective items were resolved or unresolved, as applicable.

f. Itemized changes authorized by the RDPRC and AHJ if not included in a defective item.

E. Submittal Schedule.

1. Documentation of reports, test results, and non-compliant work will be submitted at the frequency indicated in the SSI.

F. Final Report of Special Inspections.

1. Each agent listed in the SSI will submit a final report to the Approved Agency documenting the performed special inspections and the correction of any discrepancies noted. The Approved Agency will cumulate the reports and submit a comprehensive final report at a point in time as agreed upon by the permit applicant and the AHJ prior to the start of work.

End of Section

01 45 33 Appendix A

Forms for Use by Contractor and Fabricators

Contractor's Statement of Responsibility

Each Fabricator, Contractor, or Supplier responsible for the construction or fabrication of a system or component designated in the Statement of Special Inspections shall submit this Statement of Responsibility.

Project:
Contractor's or Supplier's Name:
Address:
License No.:

Description of designated building systems and components included in this Statement of Responsibility:

Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the Code Required Special Inspections and Tests program and the Schedule of Special Inspections.

I hereby acknowledge that control will be exercised to obtain conformance with the construction documents.

Signature _____ Date _____

Title _____

Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of their shop fabricated items shall submit this *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project:
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 construction documents.

Signature

Date

Title

01 45 33 Appendix B

Forms for Use by Approved Agency

Request for Approval of Individual Inspector or Testing Technician

Project:
Project Address:
Name of Inspection/Testing Agency:
Address:
Phone Number:
Name of Primary Inspection Agency's manager/supervisor:

Special Inspector or Testing Technician Name:

Special Inspector or Testing Technican Signature: _____
(as it will appear on reports)

This individual is qualified to inspect:

[ ] Verification of Soils
[ ] Earth Retaining Structure
[ ] Excavation and Filling
[ ] Piling
[ ] Drilled Piers
[ ] Testing of Concrete
[ ] Placement of Concrete
[ ] Placement of Shotcrete
[ ] Placement of Rebar
[ ] Prestressing Concrete
[ ] High Strength Bolting
[ ] Structural Welding
[ ] Steel Frame Inspection
[ ] Structural Masonry
[ ] Erection of Precast
[ ] Inspection of Fabricators
[ ] Precast Fabrication
[ ] Structural Steel
[ ] Metal Building
[ ] EIFS Inspection
[ ] Smoke Control
[ ] Seismic Resistance
[ ] Sprayed Fireproofing
[ ] Architectural Systems
[ ] Mechanical Systems
[ ] Electrical Systems

Current certifications and/or professional licenses retained by the individual:

[ ] Professional Engineer
[ ] Geotechnical Engineer
[ ] Structural Engineer
[ ] Registered Architect
[ ] Registered Geologist
[ ] EI/EIT (min. of 1 yr. related experience)
[ ] GIT (min. of 1 yr. related experience)
[ ] ACI Concrete Field Testing Technician Grade 1
[ ] ACI Concrete Construction Inspector
[ ] ACI Laboratory Testing Technician, Grade 1 or 2
[ ] ACI Strength Testing Technician
[ ] AWS Certified Welding Inspector
[ ] AWS/AISC Certified Structural Steel Inspector
[ ] ASNT NDT Technician Level II or III
[ ] ICC Building Inspector
[ ] ICC Structural Masonry
[ ] ICC Structural Steel and Welding
[ ] ICC Spray-Applied Fire Proofing
[ ] ICC Prestressed Concrete
[ ] ICC Reinforced Concrete
[ ] ICC Structural Steel and Bolting
[ ] ICC Structural Welding
[ ] NCMA Concrete Masonry Testing Technician
[ ] NICET Concrete Technician Level II, III, or IV
[ ] NICET Soils Technician Level II, III, or IV
[ ] NICET Geotechnical Engineering Technician Level II, III, or IV
[ ] EDI EIFS
[ ] Other _____

Copies of current certifications and/or professional licenses and a resume showing the individual's work experience are attached.

I hereby certify that in my judgment the individual is qualified to inspect and/or test the items indicated above.

Primary Special Inspection Agency:

Signed:_____Date:_____
(Primary inspection agency's manager/supervisor)

Final Report of Special Inspections

Project:
Project Address:

Testing / Inspection Agent:
Testing / Inspection Agent Address:
Scope of Testing / Inspections:

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 completed in accordance with the contract documents. Based upon my personal observations and written reports, it is my judgment that the inspected work was performed, to the best of my knowledge, in accordance with the building department approved design drawings, specifications, approved change orders, and applicable workmanship provisions of the governing building code.

Interim reports submitted prior to this final report and numbered _____ to _____, form a basis for, and are to be considered an integral part of this final report.

The following discrepancies that were outstanding since the last interim report dated have been corrected:

Items not in conformance, unresolved items or any discrepancies in inspection coverage (i.e., missed inspections, periodic inspections when continuous was required, etc.) are as follows:

Special Inspector's Seal

Prepared By:

Type or print name

Signature Date

(Licensed Professional)

Appendix C

Statement of Special Inspections

Project:
Project Address:
Permit Applicant:
Applicant Address:
Owner:
Owner Address:

Registered Design Professional in Responsible Charge (RDPRC) :

Discipline	Name	License Number	Expiration Date
Structural Engineer			
Geotechnical Engineer			
Mechanical Engineer			
Electrical Engineer			
Architect			

This Statement of Special Inspections includes a *Schedule of Special Inspections* applicable to the above referenced project as well as the identity of the individuals, agencies, or firms intended to be retained for conducting these inspections.

The Special Inspector(s) shall keep records of all inspections and shall furnish interim inspection reports to the Authority Having Jurisdiction (AHJ) and to the Registered Design Professional in Responsible Charge (RDPRC). Discrepancies shall be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the AHJ and the RDPRC prior to completion of that phase of work. A *Final Report of Special Inspections* documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted by each agent.

Inspection work shall be performed in accordance with the following codes and standards. Unless otherwise indicated within the Statement of Special Inspections, the applicable edition for all codes and standards shall be as follows.

Work	In Accordance With
Building Code	2021 International Building Code (IBC)
Seismic Criteria for Nonstructural Components	ASCE 7-16
Standard Tests and Practices	ASTM International specifications
Concrete	ACI 318-19 and ACI 350-20
Structural Steel	AISC 360-16 and AISC 341-16
Structural steel welding	AWS D1.1 Structural Welding Code - Steel
Aluminum welding	AWS D1.2 Structural Welding Code – Aluminum
Sheet steel welding	AWS D1.3 Structural Welding Code – Sheet Steel
Structural steel bolting	Research Council on Structural Connections Specification for Structural Joints Using High Strength Bolts, August 1, 2014

Work	In Accordance With
Intumescent Fire-Resistive Coating	Association of the Wall and Ceiling Industry (AWCI) Technical Manual 12-B, Second Edition; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide

RDPRC - Structural	RDPRC - Civil/Geotechnical	RDPRC - Mechanical
RDPRC – Electrical	RDPRC - Architect	

Owner's Acknowledgement:

Signature Date

Acceptance by Authority Having Jurisdiction:

Signature Date

Permit No.

Frequency of interim report submittals to AHJ:

□ 1 week □ 2 weeks □ Monthly □ Bi-Monthly □ At Completion □ Per attached Schedule

Statement of Special Inspections
(Schedule of Inspections)

The attached tables as listed below define the applicable Special Inspections and Procedures.

Table 1 of 9	Geotechnical Special Inspections
Table 2 of 9	Structural Special Inspections
Table 3 of 9	Architectural Special Inspections
Table 4 of 9	Inspections for Special Cases
Table 5 of 9	Testing for Special Inspections
Table 6 of 9	Special Inspections for Seismic Resistance
Table 7 of 9	Testing for Seismic Resistance
Table 8 of 9	NOT USED
Table 9 of 9	Individual Inspection and Testing Agents

The Seismic Design Category for the project is **C**.

The wind speed, V, for the project is **111** mph (3 second gust) and the wind exposure category is **C**.

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Soils						
Verify material below foundation is adequate to achieve design bearing capacity, free of loose, deleterious or foreign material in accordance with specification Section 31 23 11	1705.6			**X** (foundation excavation complete)		
Verify excavations for structures are extended to proper depth, proper size and material in accordance with specification Section 31 23 11.	1705.6			**X** (foundation excavation complete)		
Prior to placement of controlled fill, inspect subgrade and verify site is properly prepared in accordance with specification Section 31 23 11.	1705.6			**X** (prior to placement of fill)		
Perform classification and testing of compacted fill material to verify compliance with specifications.	1705.6			**X** (during placement of fill)	See Excavation and Fill for Structures specification section.	
Verify materials, densities, and lift thicknesses during placement and compaction of controlled fill for foundations in accordance with specification Section 31 23 11. Note the exception of Article 1705.6.	1705.6		**X**			

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Driven Deep Foundation Elements						
Piling material verification (certified mill test reports), sizes and lengths.	1705.7		**X**		Refer to Table 2 for additional material-specific requirements.	
Determine capacities of test piles and conduct additional load tests as required.	1705.7		**X**			
Driving operations and maintain records for each pile.	1705.7		**X**			
Installation: Location, plumbness, tip and cutoff elevations, hammer, blows per foot, penetration to achieve design capacity, splices, damage to pile.	1705.7		**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Other Reference**	**Frequency**			
			Continuous	**Periodic**		
Structural Load-Bearing Members Fabricated in a Shop						
Confirm the "Fabricator's Certificate of Compliance" has been received and accepted by RDPRC and AHJ for the fabricated items.	1704.2.5.1 1704.5 1705.11			**X**	At end of fabrication, and prior to installation of the shop fabricated items in the work.	
Concrete (inspections not required for nonstructural concrete slabs supported directly on the ground)						
Reinforcing steel and prestressing tendon condition (free of oil, dirt and loose rust and that properly coated and/or sheathed) and placement. Verify size, spacing, bar clearances, cover, and adequate support to prevent displacement during concrete placement. Verify lap splices, mechanical splices, and embedment lengths. Verify dowels for work above are properly aligned and spaced to match other work.	1705.3	ACI 318 (Ch. 20) ACI 318 (25.2-25.3) ACI 318 (26.6.1-26.6.3		**X** (prior to closing of forms or delivery of concrete, for each placement)		
Cast-in-place anchor bolts prior to and during placement of concrete.	1705.3	ACI 318 (26.7.2)	**X**		All bolts visually inspected to verify anchor diameter, location, and embedment length.	
Verify use of approved mix design(s).	1705.3	ACI 318 (26.4.3-26.4.4)		**X**	RDPRC to approve contractor's proposed mix design prior to construction. Inspector to verify from concrete delivery ticket that the appropriate mix has been provided prior to placement.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Formwork shape, location, and dimensions of the concrete member being formed, construction joints properly prepared.	1705.3	ACI 318 (26.11.1.2(b))		**X** (prior to delivery of concrete for each placement)		
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 C31 ASTM C172 ACI 318 (26.12)		**X**	Sampling and testing frequency shall be as indicated in the cast-in-place concrete specification.	
Concrete placement.	1705.3	ACI 318 (26.5.2)	**X**		Verify that water added at the site does not exceed that allowed by the mix design. Verify conveying, depositing, and consolidation of concrete. Observe placement procedures for evidence of segregation, possible cold joints, displacement of reinforcing or forms, and proper support of embedded items, anchor bolts, etc.	
Concrete curing – maintain temperature and techniques.	1705.3	ACI 318 (26.5.3-26.5.5)		**X** (during hot, cold, and windy conditions)	For wet-curing, check at the beginning of each day during 7 day curing period	
Prestressed concrete: application of prestressing forces. Verify that tendons are correctly positioned, supported, tied and wrapped. Record tendon elongations.	1705.3	ACI 318 (26.10.2)	**X**		Review current calibration data on the proposed stressing equipment	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Prestressed concrete: grouting of bonded prestressing tendons.	1705.3	ACI 318 (26.13.3.2(b))	**X**			
Erection of precast members.	1705.3	ACI 318 (26.9)		**X**	Verify member configuration, connections, welding and grouting. All connections visually inspected. Modifications or damage to precast members shall be reported as a discrepancy. Refer to additional requirements for anchor bolts and welding.	
Precast concrete diaphragms using moderate or high deformability elements for connections or joint reinforcement, assigned to Seismic Design Categories C, D, E, or F.	1705.3	ACI 318 (26.13.1.3)	**X**		Inspect connections and joint reinforcement for: • installation of the embedded parts. • completion of the continuity of reinforcement across joints. • completion of field connections.	
Installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5.	1705.3	ACI 318 (26.13.1.3) ACI 550.5		**X**		
Verification of in-situ concrete strength prior to stressing of tendons in posttensioned concrete.	1705.3			**X** (prior to tensioning operations)		
Verification of in-situ concrete strength prior to removal of forms and shores from elevated beams and slabs.	1705.3	ACI 318 (26.11.2)		**X** (prior to form or shore removal)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Verification of in-situ concrete strength prior to backfilling against walls.				**X** (prior to backfilling operations)		
Shotcrete						
Reinforcing steel and prestressing tendon condition (free of oil, dirt and loose rust and that properly coated and/or sheathed) and placement. Verify size, spacing, bar clearances, cover, and adequate support to prevent displacement during shotcrete placement. Verify lap splices, mechanical splices, and embedment lengths. Verify dowels for work above are properly aligned and spaced to match other work.	1705.3	ACI 318 (Ch. 20) ACI 318 (25.2-25.3) ACI 318 (26.6.1-26.6.3		**X** (prior to delivery of shotcrete, for each placement)		
Cast-in-place anchor bolts prior to and during placement of shotcrete.	1705.3	ACI 318 (26.7.2)	**X**		All bolts visually inspected to verify anchor diameter, location, and embedment length.	
Verify use of required mix design(s).	1705.3	ACI 318 (26.4.3-26.4.4)		**X**	RDPRC to approve contractor's proposed mix design prior to construction. Inspector to verify from shotcrete delivery ticket that the appropriate mix has been provided prior to placement.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Other Reference**	**Frequency**			
			Continuous	**Periodic**		
Shape, location, and dimensions of the shotcrete member, construction joints properly prepared.	1705.3			**X** (prior to delivery of shotcrete for each placement)		
At the time fresh shotcrete is sampled to fabricate test panels for strength tests, perform slump and air content test, and determine the temperature of the shotcrete.	1705.3	ASTM C172 ACI 318 (26.12)		**X**	Sampling and testing frequency shall be as indicated in the shotcrete specification.	
Shotcrete placement.	1705.3	ACI 506.2	**X**		Verify that water added at the site does not exceed that allowed by the mix design. Verify spray distance, thickness control measures, and rebound control of shotcrete, as well as proper support of embedded items. Observe placement procedures for evidence of sagging, sloughing, segregation, and sand pockets.	
Shotcrete curing – maintain temperature and techniques.	1705.3	ACI 506.2		**X** (during hot, cold, and windy conditions)	For wet-curing, check at the beginning of each day during 7 day curing period.	
Prestressed shotcrete: application of prestressing forces.	1705.3	ACI 318 (26.10.2)	**X**		Review current calibration data on the proposed stressing equipment.	
Structural Steel						
Main structural steel elements: review material test reports.	1705.2.1	AISC 360 (A3.1) AISC 360 (N5.2)		**X**	3 pieces from each lot; verify at fabricator's shop prior to cutting.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
Steel castings and forgings: review material test reports.		1705.2.1	AISC 360 (A3.2) AISC 360 (N5.2)		**X**	Each lot.	
Anchor rods and threaded rods: review material test reports.		1705.2.1	AISC 360 (A3.4) AISC 360 (N5.2)		**X**	Each lot.	
Headed stud anchors: review manufacturer's certifications.		1705.2.1	AISC 360 (A3.6) AISC 360 (N5.2)		**X**	Each lot.	
Galvanized steel members: inspect exposed cut surfaces of galvanized main members and rectangular HSS for cracks after galvanizing.		1705.2.1	AISC 360 (N5.7)		**X**	Each main member and HSS shape. Inspect at jobsite.	
Verify the following prior to welding:							
	Welding consumables: review manufacturer's certifications.	1705.2.1	AISC 360 (A3.5) AISC 360 (N5.2) AISC 360 (N5.4)		**X**	3 rods from each lot; verified at fabricator's shop and at jobsite.	
	Welding filler metals and fluxes: review manufacturer's product data sheets or catalog data.	1705.2.1	AISC 360 (N5.2)		**X**	Each lot. Review products, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, includng baking, if applicable.	
	Welding procedures specifications (WPS's): review procedures.	1705.2.1	AISC 360 (N5.2) AISC 360 (N5.4)		**X**	For each welded joint or member.	
	Welding procedures not prequalified per AWS D1.1 or D1.3: review procedure qualification records (PQR's).	1705.2.1	AISC 360 (N5.2)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	Welding personnel qualification records (WPQR's) and continuity records: review welder qualifications.	1705.2.1	AISC 360 (N5.2) AISC 360 (N5.4)		**X**	Perform for each welder.	
	Welder identification system: review system of marking joints for purpose of identifying welders.	1705.2.1	AISC 360 (N5.4)		**X**		
	Fit up of groove welds: observe joint preparations, dimensions, cleanliness, tacking, and backing.	1705.2.1	AISC 360 (N5.4)		**X**		
	Fit up of CJP groove welds of HSS T-, Y-, and K- joints without backing: observe joint preparations, dimensions, cleanliness, and tacking.	1705.2.1	AISC 360 (N5.4)		**X**		
	Access holes: configuration and finish.	1705.2.1	AISC 360 (N5.4)		**X**		
	Fit up of fillet welds: observe dimensions, cleanliness, and tacking.	1705.2.1	AISC 360 (N5.4)		**X**		
Verity the following during welding:							
	Welding consumables: packaging and appropriate exposure control.	1705.2.1	AISC 360 (N5.4)		**X**		
	No welding over cracked tack welds.	1705.2.1	AISC 360 (N5.4)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	Environmental conditions: wind speed, precipitation, and ambient temperature limits are observed.	1705.2.1	AISC 360 (N5.4)		**X**		
	Welding procedure specifications (WPS's): settings on welding equipment, travel speed, selected welding materials, shielding gas type/flow rate, preheat applied, interpass temperature maintained (min/max), proper position.	1705.2.1	AISC 360 (N5.4)		**X**		
	Welding techniques: interpass and final cleaning, each pass is within profile limitations, each pass meets quality requirements.	1705.2.1	AISC 360 (N5.4)		**X**		
	Headed stud anchors: placement and installation of anchors.	1705.2.1	AISC 360 (N5.4)		**X**	Observe once daily for each welder and visually inspect all anchors at the completion of their welding.	
Verify the following after welding:							
	Welds cleaned.	1705.2.1	AISC 360 (N5.4)		**X**		
	Weld size, length and location.	1705.2.1	AISC 360 (N5.4)	**X**			
	Welds meet visual inspection criteria (crack prohibition, weld/base metal fusion, crater cross section, weld profiles, weld size, undercut, porosity).	1705.2.1	AISC 360 (N5.4)	**X**			
	Arc strikes.	1705.2.1	AISC 360 (N5.4)	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	K-area.	1705.2.1	AISC 360 (N5.4)	**X**		When welding doubler, continuity, or stiffener plates in the k-area of a web, visually inspect the web k-area for cracks within 3 inches of the weld.	
	Weld access holes in rolled heavy shapes and bult-up heavy shapes.	1705.2.1	AISC 360 (N5.4)	**X**		Visually inspect the weld access holes for cracks after welding.	
	Backing removed and weld tabs removed.	1705.2.1	AISC 360 (N5.4)	**X**			
	Repair activities.	1705.2.1	AISC 360 (N5.4)	**X**			
	Document acceptance or rejection of welded joint or member.	1705.2.1	AISC 360 (N5.4)	**X**			
	No prohibited welds have been added without approval of EOR.	1705.2.1	AISC 360 (N5.4)		**X**		
Verify the following prior to bolting:							
	Fasteners: review manufacturer's certifications.	1705.2.1	AISC 360 (A3.3) AISC 360 (N5.2) AISC 360 (N5.6)		**X** (3 bolts from each lot)	Verified at jobsite.	
	Fasterners: review markings per ASTM requirements.	1705.2.1	AISC 360 (N5.6)		**X**		
	Correct fasteners selected for the joint detail (grade, type, bolt length).	1705.2.1	AISC 360 (N5.6)		**X**		
	Correct bolting procedure selected for joint detail.	1705.2.1	AISC 360 (N5.6)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	Connecting elements, including the appropriate faying surface condition (for slip-criitcal joints) and hole preparation.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.3)		**X**		
	Pre-installation verification testing by installing personnel.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2)		**X**	Required for all pretensioned and slip-critical joints.	
	Protected storage for bolts, nuts, washers, other fastener components.	1705.2.1	AISC 360 (N5.6)		**X**		
	Pretensioned joints; direct tension indicator.	1705.2.1	RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.4)		**X**	Verify the appropriate feeler gage is accepted in at least half ot the spaces between the protrusions, and that the protrusions are properly oriented away from the work.	
Verify the following during bolting:							
	Fastener assemblies placed in all holes and washers and nuts positioned as required.	1705.2.1	AISC 360 (N5.6)		**X**		
	Joint brough to the snug-tight position prior to pretensioning.	1705.2.1	AISC 360 (N5.6)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	Fastener component not turned by the wrench is prevented from rotating.	1705.2.1	AISC 360 (N5.6)		**X**		
	Fasteners pretensioned in accordance with RCSC specification, progressing systematically from the most rigid point to the free edges.	1705.2.1	AISC 360 (N5.6)		**X**		
	Pretensioned joints; calibrated wrench.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.2)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify that the crew properly applies the calibrated wrentch to the turned element.	
Verify the following after bolting:							
	Snug-tight joints.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.1)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Nuts shall not be turnable without a wrench.	
	Pretensioned joints; turn-of-nut.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.1)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the turned element is rotated relative to the unturned element by the amount indicated in RCSC Table 8.2.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Other Reference**	**Frequency**			
				Continuous	**Periodic**		
	Pretensioned joints; twist-off type tension control bolts.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.3)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the splined ends are properly severed.	
	Pretensioned joints; direct tension indicator.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.4)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the appropriate feeler gage is refused entry into at least half ot the spaces between the protrusions.	
After bolting, document acceptance or rejection of bolted connections.		1705.2.1	AISC 360 (N5.6)		**X**		
Railing systems composed of structural steel elements.		1705.2.1	AWS D1.1 (Section 6.9)		**X**	Inspection required only at the base of cantilevered rail posts.	
Verification of steel frame braces, stiffeners, member locations and joint details.		1705.2.1	AISC 360 (N5.8)		**X**	At 50% complete and 100% complete, for each structure.	
Proprietary moment resisting frame connection systems.		1703.4.2				Refer to welding and high strength bolting requirements.	
Open Web Steel Joists and Joist Girders							
End connections, welded or bolted.		1705.2.3	SJI Specifications		**X**		
Standard bridging, horizontal or diagonal.		1705.2.3	SJI Specifications		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Bridging that differs from the SJI Specifications.	1705.2.3			**X**		
Steel Deck						
Prior to deck placement, verify compliance of deck and accessories with construction documents, including profiles, material properties, and base metal thickness.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of deck and accessories.	
After deck placement, verify deck mill certiifications and compliance of deck and accessories installation.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of deck and accessories.	
Prior to welding, observe welding procedure specifications, welding consumables certifications, welding material types and grades, and welding equipment.	1705.2.2	SDI QA/QC Standard		**X** (all materials)		
During welding, observe the use of qualified welders, control and handling of welding consumables, environmental conditions, and following of welding procedure specifications.	1705.2.2	SDI QA/QC Standard. AWS D1.3	**X** (all materials)			
After welding, verify size and location of all welds (at supports, sidelaps, and perimeters), verify welds meet visual acceptance criteria, and verify repair activities.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of welds.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			**Continuous**	**Periodic**		
Prior to mechanical fastening, verify manufacturer's installation instructions and proper tools are available.	1705.2.2	SDI QA/QC Standard		**X** (all materials)		
During mechanical fastening, verify fasteners are positioned as required and are installed in accordance with the manufacturer's instructions.	1705.2.2	SDI QA/QC Standard	**X** (all materials)			
After mechanical fastening, verify spacing, type, and installation of all fasteners (at supports, sidelaps, and perimeters), and verity repair activities.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of mechanical fasteners.	
Post-Installed Anchors – Expansion and Undercut Anchors into Concrete						
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		**X**	Continuous inspection is required if mandated by manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Concrete						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Other Reference**	**Frequency**			
			Continuous	**Periodic**		
Adhesive anchors installed in overhead, upwardly inclined, or horizontal positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report	**X**			
Adhesive anchors installed in other positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		**X**	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically, unless continuous inspections are mandated by the manufacturer's research report. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection.	
Aluminum						
Material verification of structural aluminum: Certified mill test reports.	1705.1.1			**X** (each mill order)		
Material verification of bolts: Manufacturer's certified test reports.	1705.1.1			**X** (each lot)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Material verification of weld filler metals.	1705.1.1	AWS D1.2 (Section 5)		**X** (3 rods from each lot)	Checked at fabricator's shop and at jobsite.	
Verify use of proper WPS's.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Complete and partial penetration groove welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			
Multipass fillet welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			
Single pass fillet welds.	1705.1.1	AWS D1.2 (Section 5)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		

Schedule of Special Inspections - Table 3 of 9 (Architectural Special Inspections)						
	Inspection					
	Building Code Reference	Other Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Fire-Resistant Penetrations and Joints						
Penetration firestops (locations indicated on drawings).	1705.18.1			**X**	Systems that are tested and listed in accordance with IBC Sections 714.4.1.2 and 714.5.1.2 shall be inspected in accordance with ASTM E2174.	
Fire-resistant joint systems (locations indicated on drawings).	1705.18.2			**X**	Systems that are tested and listed in accordance with IBC Sections 715.3.1 and 715.4 shall be inspected in accordance with ASTM E2393.	
Smoke Control Systems						
Installation.	1705.19			X	Record device location(s).	

Schedule of Special Inspections - Table 4 of 9 (Inspections for Special Cases)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Pre-Engineered Structures						
Fabrication and erection	1705.1.1				Refer to Table 2 for fabricator, welding, and high strength bolting special inspection requirements.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Testing				
System or Material	**Building Code Reference**	**Other Reference**	**Frequency**	**Remarks**	**Testing Agent No.** (see Table 9)
Geotechnical					
Classification of controlled fill material.	1705.6	ASTM D2487 and ASTM D2488	One per stratum of on-site excavated material. One per common supply of off-site material.	See Excavation and Fill for Structures specification section.	
Foundation subgrade, in-place density.	1705.6	ASTM D6938 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 1,000 SY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	See Excavation and Fill for Structures specification section.	
Controlled fill beneath foundations, in-place density.	1705.6	ASTM D6938 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 200 CY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	See Excavation and Fill for Structures specification section.	
For deep foundation elements where the structural integrity is in doubt, test for defects as instructed by engineer.	1705.10		Each pile that is suspected to have defects.		
Concrete					
Concrete strength.	1705.3	ASTM C31 ASTM C39 ASTM C172	See concrete specification.	See concrete specification for quantity of cylinders.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Testing				
System or Material	**Building Code Reference**	**Other Reference**	**Frequency**	**Remarks**	**Testing Agent No.** (see Table 9)
Concrete slump, air content, temperature, unit weight, water soluble chloride ion, shrinkage.	1705.3	ASTM C31 ASTM C138 ASTM C143 ASTM C157 ASTM C172 ASTM C231 ASTM C1064 ASTM C1218	See concrete specification.		
Shotcrete					
Preconstruction tests.	1704.5	ASTM C1140	Prior to construction work.	See shotcrete specification for required scope of preconstruction testing.	
Shotcrete strength.	1705.3	ASTM C1140	See shotcrete specification.		
Steel					
Penetrant (PT), magnetic particle (MT), radiographic (RT) and ultrasonic (UT) testing of welds.	1705.2	PT – AWS D1.1 (6.10 & 6.14.5) MT - AWS D1.1 (6.10 & 6.14.4) RT – AWS D1.1 (6.12 & 6.14.1) UT - AWS D1.1 (6.13 & 6.14.3)		**10% of all CJP and PJP groove welds, multipass fillet welds, single pass fillet welds larger than 5/16, and plug/slot welds.**	
Welded studs: pre-construction testing.	1705.2	AWS D1.1 (7.7.1)	At beginning of each shift's production, test the first two studs that are welded.	Each size and type of stud.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Testing				
System or Material	**Building Code Reference**	**Other Reference**	**Frequency**	**Remarks**	**Testing Agent No.** (see Table 9)
Welded studs: post-construction testing.	1705.2	AWS D1.1 (7.8)	All studs not showing full 360° flash or any stud that has been repaired by welding.	Test by bending studs to 15° from vertical, away from weld discontinuity.	
Aluminum					
Liquid penetrant (PT) and radiographic (RT) testing of welds.		PT - AWS D1.2 (5.7.5) RT - AWS D1.2 (5.10 & 5.15)			
Smoke Control Systems					
Leakage and pressure differential and flow measurement.	1705.19.1		Determined by jurisdiction.	During erection of ductwork and prior to concealment.	
Detection and control verification.	1705.19.1		Determined by jurisdiction.	Prior to occupancy and after sufficient completion to execute tests.	

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)						
Visually inspect the following before welding: material type and grade; welder identification system; fit up of groove welds including joint preparation, dimensions, cleanliness, tacking, backing type and fit; configuration and finish of access holes; fit up of fillet welds including dimensions, cleanliness and tacking.	1705.13.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect during welding: WPS followed, use of qualified welders, control and handling of welding consumables, environmental conditions, welding techniques, no welding over cracked tacks.	1705.13.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect after welding: Welds cleaned, size, length, and location of welds.	1705.13.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	Building Code Reference	Other Reference	Continuous	Periodic	Remarks	Inspection Agent No. (see Table 9)
Visually inspect welds after welding to acceptance criteria for: crack prohibition, weld/base metal fusion, crater cross section, weld profile, weld size, undercut, and porosity.	1705.13.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
When welding doubler, continuity, or stiffener plates in the k-area of a web, visually inspect the web k-area for cracks.	1705.13.1	AISC 341 (J6.1)	**X**		Inspection area shall include the k-area base metal within 3 inches of the weld. Inspection shall be performed no sooner than 48 hours following completion of the welding.	
Visually inspect welds after welding for placement of reinforcement fillets, removal of backing bars and weld tabs and finish (where required on drawings or per specifications), and repair activities.	1705.13.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Prior to high strength bolting: verify proper fasteners and bolting procedures selected for the detail, connecting elements fabricated properly including faying surface preparation and hole preparation, proper storage for bolts, nuts, washers and other components.	1705.13.1	AISC 341 (J7)		**X** (Once daily for each bolting crew)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Other Reference**	**Frequency**			
			Continuous	**Periodic**		
During high strength bolting: Fasteners assemblies properly positioned, joints snug tight prior to pretensioning, fastener component not turned by the wrench prevented from rotating, pretensioning progresses systematically from most rigid point to free edges.	1705.13.1	AISC 341 (J7)		**X** (observe once daily for each bolting crew)		
After installation of high strength bolting, document accepted and rejected connections.	1705.13.1	AISC 341 (J7)		**X** (at completion of each connection)		
At Reduced Beam Sections (RBS), verify contour, finish, and dimensional tolerances.	1705.13.1	AISC 341 (J8)		**X** (at completion of fabrication of applicable beam)		
Plumbing and Mechanical Components						
Installation of automatic fire sprinkler systems that do not have flexible sprinkler hose fittings. Verify 3 inch minimum clearances between the sprinkler drops and sprigs and: • Permanently attached mechanical or electrical equipment, including ductwork, other piping systems, and their associated structural supports and bracing. • Structural members not used as supports of the sprinkler system.	1705.13.6	ASCE 7, Section 13.2.3.		**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Electrical						
Anchorage of electrical equipment for emergency and standby power.	1705.13.6			**X** (observe completed installation of each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components that must be anchored.	
Nonstructural Components						
For non-structural components that are qualified by means of shake table testing or experience data, verify that the label, anchorage, and mounting conform to the certificate of compliance furnished by the product manufacturer.	1705.13.4	ASCE 7 (13.2.2)		**X** (Each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Testing				
System or Material	**Building Code Reference**	**Other Reference**	**Frequency**	**Remarks**	**Testing Agent No.** (see Table 9)
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)					
Ultrasonic (UT) of base metal thicker than 1-1/2" subject to through-thickness weld shrinkage strains. Test is for discontinuities behind and adjacent to each weld.	1705.14.1	AWS D1.1(6.13 & 6.14.3)	Each weld		
For CJP groove welds in material 5/16” thick and greater, perform ultrasonic testing (UT).	1705.14.1	AISC 341 (J6.2)	Each weld	Weld discontinuities shall be accepted or rejected on the basis of critiera of AWS D1.1 Table 6.2. In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for possible reduction in testing frequency.	
For beam to column CJP groove welds, perform magnetic particle testing (MT).	1705.14.1	AISC 341 (J6.2)	25% of all such welds for each welder	In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for permitted reduction in testing frequency.	
For PJP groove welds in column splices and in column to base plate welds, perform ultrasonic testing (UT).	1705.14.1	AISC 341 (J6.2)	Each weld	UT shall be performed using written procedures and UT technicians qualified in accordance with AWS D1.8. Refer to AISC 341 for weld joint mock-up requirements.	
When base metal thicker than 1-1/2" is loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than 3/4” thick and contains CJP welds, perform ultrasonic testing (UT) to detect discontinuities behind and adjacent to the fusion line of each weld.	1705.14.1	AISC 341 (J6.2)	Each weld	See AISC 341 for permitted reduction in testing frequency.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Testing				
System or Material	**Building Code Reference**	**Other Reference**	**Frequency**	**Remarks**	**Testing Agent No.** (see Table 9)
For welded splices and connections, perform magnetic particle testing (MT) or liquid penetrant testing (PT) at thermally cut surfaces of beam copes and access holes when the flange thickness exceeds 1-1/2" for rolled shapes or the web thickness exceeds 1-1/2" for built-up shapes.	1705.14.1	AISC 341 (J6.2)	Each weld		
For reduced beam section (RBS) plastic hinge regions repaired by welding, or on the base metal of reduced beam section (RBS) plastic hinge region if a sharp notch has been removed by grinding, perform magnetic particle testing (MT) on the weld and the adjacent area.	1705.14.1	AISC 341 (J6.2)	Each weld or location		
For welds where weld tabs have been removed, except for continuity plate weld tabs, perform magnetic particle testing (MT) on the ends of the weld.	1705.14.1	AISC 341 (J6.2)	Each weld or location	See AISC 341 for permitted reduction in testing frequency.	
Pre-installation testing of fastener assemblies and methods used.	1705.14.1	AISC 341 (J7) RCSC Specification for Structural Joints Using High Strength Bolts (Section 7)	3 assemblies of each diameter, grade, length, and lot prior to use		
Non-Structural Components (Architectural, Mechanical and Electrical)					
For non-structural components and their anchorage that are qualified by means of analysis, testing, or experience data, examine the certificate of compliance furnished by the product manufacturer.	1705.14.2 1705.14.3	ASCE 7 (13.2.1, part 2), ASCE 7 (13.2.2 parts 1, 2)	Each applicable piece of equipment	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	

Schedule of Special Inspections - Table 8 of 9 (Special Inspections for Wind Resistance) NOT USED						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Other Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (See Table 9)

Schedule of Special Inspections - Table 9 of 9 (Individual Inspection and Testing Agents)					
NAME	**LICENSE NO.**	**FIRM**	**ADDRESS**	**EMAIL**	**PHONE NO.**
1.					( )
2.					( )
3.					( )
4.					( )
5.					( )
6.					( )
7.					( )
8.					( )
9.					( )
10.					( )

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SECTION 01 45 35 - CODE REQUIRED STRUCTURAL OBSERVATIONS

PART 1 - GENERAL

1.1 SCOPE.

A. Owner will engage one or more Registered Design Professionals to perform Structural Observation (SO) as specified in this section. SO are not to be considered as part of the broader Special Inspections (SI) program.

1.2 GENERAL.

A. SO does not limit Contractor's other quality-assurance and quality control procedures that facilitate compliance with the construction documents.

B. Requirements for Contractor to provide quality assurance and quality control services required by Engineer, Owner, or Authority Having Jurisdiction (AHJ) are not limited by provisions of this Section.

1.3 DEFINITIONS.

A. Authority Having Jurisdiction (AHJ): The officer or other designated authority charged with the administration and enforcement of the building code, or a duly authorized representative. Also commonly known as the Building Official.

B. Registered Design Professional (RDP): 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.

C. Special Inspection (SI): Inspection and/or testing required by the governing building code, as amended by the AHJ, of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved Construction Documents and referenced standards.

D. Structural Observation (SO): Visual observation of the structural system by a Registered Design Professional for general conformance to the approved Construction Documents.

1.4 TECHNICAL ATTACHMENTS.

A. The following forms are required as part of the SO requirements. The forms are available from the AHJ, or are included herein, as indicated:

Form Title	Notes
Structural Observations Plan	To be completed and sealed by the RDP. RDP will submit the form to the AHJ prior to the start of construction.
Final Report of Structural Observations	To be completed and sealed by the RDP. RDP will submit the form to the AHJ at the completion of construction.

PART 2 - PRODUCTS (NOT USED).

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES.

A. Contractor shall assist in coordination of the SO services during the progress of the work. Contractor shall provide sufficient notice to RDP to allow proper scheduling. Contractor shall provide safe access to RDP and shall ensure that all work requiring observation is accessible prior to concealment.

B. Contractor shall submit schedules to Owner and RDP. Schedules shall note milestones and durations of time available for the given structure(s) to be observed.

C. Contractor shall repair and/or replace work that does not meet the requirements of the construction documents.

D. Contractor shall be responsible for costs of:

1. Follow-up observation of construction that does not initially meet the requirements of the Contract Documents or shop drawing/submittal data.

2. Review of proposed repair and/or replacement procedures by the RDP.

3. Repair or replacement of work that does not meet the requirements of the Construction Documents.

3.2 REGISTERED DESIGN PROFESSIONAL RESPONSIBILITIES.

A. Structural Observations Plan.

1. Prior to the commencement of observations, submit to the AHJ a written statement identifying the frequency and extent of SO.

B. Perform Observations.

1. Be present for and perform SO as described in the Structural Observations Plan. Notify Contractor personnel of their presence and responsibilities. Perform SO in a timely manner to avoid delay of work. Document each site visit with a report and submit a copy to the AHJ and Contractor.

2. The RDP may delegate the site visit activity to other persons in the same firm, acting under the responsible charge of the RDP.

C. Defective Work.

1. Immediately notify Contractor of the need for corrective action when work does not conform to Construction Documents.

D. Report of Defective Work.

1. Maintain a log that identifies work that does not meet the requirements of the construction documents. Include:

a. Description and exact location.
b. Reference to applicable drawings and specifications.
c. Name and title of each individual notified and method of notification.
d. How defective items were resolved or unresolved, as applicable.
e. Itemized changes authorized by the RDP.

E. Final Report of Structural Observations.

1. At the conclusion of the work requiring observation, submit to the AHJ a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the RDP's knowledge, have not been resolved.

Structural Observations Plan

Project:
Project Address:

Registered Design Professional (Structural Observer):
RDP Address:
Scope of Structural Observations:

The structural observer (and his/her designee as appropriate) shall visually observe representative locations of structural systems, details, and load paths for general conformance to the approved construction documents. Structural observations will be performed for the following structures and systems:

- **Chemical Building**
- **Chlorine Contact Basin**
- **Junction Structure**

The RDP may delegate the site visit activity to other persons in the same firm, acting under the responsible charge of the RDP. In that situation, the RDP shall direct the delegated individual(s) in what items to record by photographs, videos, or to display via live stream communication. Detailed discussions shall occur between the RDP and the delegated staff to confirm the RDP attains a sufficient knowledge of the construction work being observed.

Items found to be in non-conformance with the construction documents shall be identified to the contractor for resolution. Any items that remain in non-conformance at the close of construction shall be identified and described in a Final Report of Structural Observations that will be presented to the Authority Having Jurisdiction.

Prepared By:

Type or print name

Signature Date

Structural Observer's Seal

(Licensed Professional)

Final Report of Structural Observations

Project:
Project Address:

Structural Observer Name:
Structural Observer Address:
Scope of Structural Observation(s):

I have completed the site visits and structural observations required for the scope described above. The observation was limited to representative locations of structural systems, details and load paths for general conformance to the design intent as defined in the approved construction documents.

To the best of my information, knowledge, and belief, the observed work is in general conformance to the design intent.

All reported deficiencies have been resolved.

The following deficiencies have not been resolved, to my knowledge:

Note that these structural observations shall not be considered part of the inspection and testing requirements under the project's Special Inspection program.

Structural Observer's Seal

Prepared By:

Type or print name

Signature Date

(Licensed Professional)

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Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 UNITS OF MEASUREMENT.

A. When both inch-pound (English) and SI (metric) units of measurement are specified herein, the values expressed in inch-pound units shall govern.

1.2 OFFICE AT SITE OF WORK.

A. During the performance of this Contract, Contractor shall maintain a suitable office at or near the Site which shall be the headquarters of its representative authorized to receive drawings, instructions, or other communication or articles.

B. Any communication given to the said representative or delivered at Contractor's office at the Site in the representative's absence shall be deemed to have been delivered to Contractor.

C. Copies of the Drawings, Specifications, and other Contract Documents shall be kept at Contractor's office at the Site and available for use at all times.

D. In addition, Contractor shall provide a suitable field for use of the Resident Project Representative (RPR) and inspectors.

1. The partitioning off of the Contractor’s own office space for use by the RPR will not be permitted.

2. The office shall be provided with an outside entrance door having a substantial lock and stairs with handrail to access the office.

3. A concrete stoop with boot scraper shall be provided at the foot of the stairs. Gravel shall be placed and maintained throughout the life of the project in a 10 foot wide area around the office perimeter.

4. Skirting shall be installed around the entire perimeter of the office, and the office shall be provided with the necessary tie downs. A pole mounted light shall be provided to adequately illuminate the area outside the office.

5. One parking space shall be reserved for the RPR next to the office with the reserved space clearly identified.

6. Windows for light and ventilation shall be provided in the RPR’s office. All windows shall be equipped with blinds. Adequate indoor lighting and thermostatically controlled heating and air conditioning shall be provided.

7. Contractor shall pay all electricity and heating bills and shall provide voice and data services as specified herein.

8. The RPR's office shall be plumbed for both hot and cold water service. A restroom located inside the office shall be provided and shall include a sink with hot and cold water service and a toilet. The office shall be furnished with a desk, a four-drawer filing cabinet, a worktable, two chairs, two plan racks, and a 2'-6" wide X 6' high bookcase with six shelves. Appliances to be provided shall include a 1.2 cubic foot, 1000 watt microwave oven and a 4.4 cubic foot refrigerator with freezer.

9. A cleaning service shall clean the RPR's office weekly throughout the project duration. All office cleaning fees shall be paid by Contractor.

10. Maintenance of the RPR's office shall be by Contractor throughout the duration of the project. Maintenance requests not resolved in 48 hours may be resolved by the RPR and the cost of such maintenance backcharged to Contractor.

11. The general arrangement of the RPR's office and facilities provided shall be acceptable to Engineer.

E. Locate the offices and other Contractor facilities to limit site disturbance as specified in the Project Requirements section.

1.3 WATER.

A. All water required for and in connection with the Work to be performed will be furnished by Owner in the vicinity of the Site without charge to Contractor, provided:

1. Contractor shall procure such water in the location and in the manner designated by Engineer.

2. Contractor at its own expense shall make authorized connections and provide means for delivering the water to the Site.

3. Contractor shall provide adequately against waste and needless use of water.

1.4 POWER.

A. Contractor shall provide all power for heating, lighting, operation of Contractor's plant or equipment, or for any other use by Contractor. Temporary heat and lighting shall be maintained until the Work is accepted.

1.5 VOICE AND DATA SERVICES.

A. Contractor shall make all necessary arrangements and pay all installation charges for data lines in its offices at the Site and for separate data lines in the office of the Resident Project Representative.

B. Data service shall be highspeed (100 mb/s) with at least two static IP addresses dedicated for the exclusive use of the Resident Project Representative's office.

1.6 SANITARY FACILITIES.

A. Contractor shall furnish temporary sanitary facilities at the Site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project.

B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. If toilets of the chemically treated type are used, at least one toilet will be furnished for each 20 persons. Contractor shall enforce the use of such sanitary facilities by all personnel at the Site.

1.7 CONSTRUCTION AIDS.

A. Contractor shall furnish, install, maintain, and operate all construction aids required by it and its Subcontractors in the performance of the Work, except as otherwise provided herein.

B. Contractor under Contract shall provide construction aids necessary for the performance of work by other contractors on the Project. Such construction aids shall be suitable for conditions encountered and shall include:

1. Elevators and hoists

2. Cranes

3. Temporary enclosures

4. Swing staging

5. Scaffolding

6. Temporary stairs

C. Construction aids shall be furnished without charge to the other contractors, and all necessary erection, maintenance, and operating personnel shall be included. In the event of conflict, the contractor furnishing the equipment shall determine priorities in the best interest of the Project.

D. The use of any plant equipment, whether furnished and installed under this Contract or not, including elevators, shop cranes, heating, ventilating, air conditioning, and plumbing fixtures, shall be only with Owner's written permission.

1.8 MAINTENANCE OF TRAFFIC.

A. Contractor shall conduct its work to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when Contractor has obtained permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point.

B. In making open-cut street crossings, Contractor shall not block more than one-half of the street at a time. Whenever possible, Contractor shall widen the shoulder on the opposite side to facilitate traffic flow. Temporary surfacing shall be provided as necessary on shoulders.

C. Temporary Bridges.

1. Contractor shall construct substantial bridges at all points where it is necessary to maintain traffic across pipeline construction. Bridges in public streets, roads, and highways shall be acceptable to the authority having jurisdiction.

2. Bridges erected in private roads and driveways shall be adequate for the service to which they will be subjected.

3. Bridges shall be provided with substantial guardrails and with suitably protected approaches.

4. Foot bridges shall be at least 4 feet wide, provided with handrails and uprights of dressed lumber. Bridges shall be maintained in place as long as the conditions of the Work require their use for safety of the public.

5. When necessary for the proper prosecution of the Work in the immediate vicinity of a bridge, the bridge may be relocated or temporarily removed for such period as Engineer may permit.

D. Detours.

1. Where required by the authority having jurisdiction that traffic be maintained over any construction work in a public street, road, or highway, and the traffic cannot be maintained on the alignment of the original roadbed or pavement,

Contractor shall, at its own expense, construct and maintain a detour around the construction work.

2. Each detour shall include a bridge across the pipe trench and all necessary barricades, guardrails, approaches, lights, signals, signs, and other devices and precautions necessary for protection of the Work and safety of the public.

1.9 BARRICADES AND LIGHTS.

A. All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersecting public highway or street on each side of the blocked section.

B. All open trenches and other excavations shall have suitable barricades, signs, and lights to provide adequate protection to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.

C. All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the Work on or alongside public streets and highways shall cause the minimum obstruction and inconvenience to the traveling public.

D. All barricades, signs, lights, and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within railroad and highway rights-of-way, as required by the authority having jurisdiction.

1.10 FENCES.

A. All existing fences affected by the Work shall be maintained by Contractor until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across the construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

B. On completion of the Work across any tract of land, Contractor shall restore all fences to their original or to a better condition and to their original locations.

1.11 PROTECTION OF PUBLIC AND PRIVATE PROPERTY.

A. Contractor shall protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by its construction operations. All pavement, surfacing, driveways, curbs, walks,

buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all sod and shrubs in yards, parkways, and medians, shall be restored to their original condition, whether within or outside the easement. All replacements shall be made with new materials.

B. No trees shall be removed outside the permanent easement, except where authorized by [Engineer][Consulting Engineer]. Whenever practicable, Contractor shall tunnel beneath trees in yards and parkings when on or near the line of trench. Hand excavation shall be employed as necessary to prevent injury to trees. Trees left standing shall be adequately protected against damage from construction operations.

C. Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or workers to or from the Work or any part or site thereof, whether by Contractor of its Subcontractors. Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

D. All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

1.12 DAMAGE TO EXISTING PROPERTY.

A. Contractor will be held responsible for any damage to existing structures, Work, materials, or equipment because of his operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of, and at no additional cost to, Owner.

B. Contractor shall protect all existing structures and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

C. Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or workers to or from the Work. Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

1.13 TREE AND PLANT PROTECTION.

A. All trees and other vegetation which must be removed to perform the Work shall be removed and disposed of by Contractor; however, no trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed shall be protected against injury from construction operations.

B. All trimming, repair, and replacement of trees and plants shall be performed by qualified nurserymen or horticulturists.

1.14 SECURITY.

A. Contractor shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

B. No Claim shall be made against Owner by reason of any act of an employee or trespasser, and Contractor shall make good all damage to Owner's property resulting from Contractor's failure to provide security measures as specified.

C. Security measures shall be at least equal to those usually provided by Owner to protect Owner's existing facilities during normal operation, but shall also include such additional security fencing, barricades, lighting, [watchman services,] and other measures as required to protect the Site.

1.15 ACCESS ROADS.

A. Contractor shall establish and maintain temporary access roads to various parts of the Site as required to complete the Project. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project.

1.16 PARKING.

A. Contractor shall provide and maintain suitable parking areas for the use of all workers and others performing work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic, Owner's operations, or construction activities.

1.17 NOISE CONTROL.

A. Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

B. During construction activities on or adjacent to occupied buildings, and when appropriate, Contractor shall erect screens or barriers effective in reducing noise in the building and shall conduct its operations to avoid unnecessary noise which might interfere with the activities of building occupants.

1.18 DUST CONTROL.

A. Contractor shall take reasonable measures to prevent unnecessary dust. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant. When practicable, dusty materials in piles or in transit shall be covered to prevent blowing dust.

B. Buildings or operating facilities which may be affected adversely by dust shall be adequately protected from dust. Existing or new machinery, motors, instrument panels, or similar equipment shall be protected by suitable dust screens. Proper ventilation shall be included with dust screens.

1.19 TEMPORARY DRAINAGE PROVISIONS.

A. Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the Site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the Site, and adjacent property.

B. Existing drainage channels and conduits shall be cleaned, enlarged, or supplemented as necessary to carry all increased runoff attributable to Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect Owner's facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided as necessary to prevent downstream flooding.

1.20 EROSION CONTROL.

A. Contractor shall prevent erosion of soil on the Site and adjacent property resulting from its construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operation that will disturb the natural protection.

B. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation shall be preserved to the greatest extent practicable. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimize erosion. Temporary fast-growing vegetation or other suitable ground cover shall be provided as necessary to control runoff.

1.21 POLLUTION CONTROL.

A. Contractor shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. No sanitary wastes shall be permitted to enter any drain or watercourse other than sanitary sewers. No sediment, debris, or other substance shall be permitted to enter sanitary sewers, and reasonable measures shall be taken to prevent such materials from entering any drain or watercourse.

1.22 PEST CONTROL.

A. Add text for pest control requirements as needed.

1.23 RODENT CONTROL.

A. Add text for pest control requirements as needed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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Section 01 61 00 - GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.1 SCOPE.

A. When an equipment specification section in this Contract references this section, the equipment shall conform to the general stipulations set forth in this section, except as otherwise specified in other sections.

1.2 COORDINATION.

A. Contractor shall coordinate all details of the equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Drawings or Specifications.

1.3 MANUFACTURER'S EXPERIENCE.

A. Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.4 WORKMANSHIP AND MATERIALS.

A. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

B. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

C. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick. When dissimilar metal components are used, consideration shall be given to prevention of galvanic corrosion.

1.5 STRUCTURAL DESIGN REQUIREMENTS.

A. All equipment, including non-structural components and non-building structures as defined in ASCE 7, and their anchorage, shall be designed and detailed in accordance with the Meteorological and Seismic Design Criteria section.

1.6 LUBRICATION.

A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

B. Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Lubricants for equipment where the lubricants may come in contact with water before or during a potable water treatment process or with potable water, shall be food grade lubricants. This includes lubricants for equipment not normally in contact with water, but where accidental leakage of the lubricants may contaminate the water.

C. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.7 ELEVATION.

A. The elevation of the site shall be as indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished shall be designed to meet stipulated conditions and to operate satisfactorily at the specified elevation.

1.8 ELECTRIC MOTORS.

A. Unless otherwise specified, motors furnished with equipment shall meet the requirements specified in Common Motor Requirements for Process Equipment section or specified in specific equipment sections.

1.9 DRIVE UNITS.

A. The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hour continuous service.

B. Gearmotors.

1. The use of gearmotors sharing an integral housing or cutgears into the motor output shaft, or that require removal of lubricant from the gear reducer to change out the motor will not be acceptable.

C. Gear Reducers.

1. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout.

D. Unless superseded by individual specification requirements each helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Cycloidal gear reducers shall have a service factor of at least 2.0 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class III. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall be designed and manufactured in compliance with applicable most current AGMA standards, except the L_{10} bearing life shall be 200, 000 hours.

E. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F .

F. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. The use of permanently sealed, grease lubricated bearings will not be acceptable in large sized reducers. In small reducers, similar to basin equipment, permanently sealed grease lubricated bearings rated L_{10} 200,000 hour life may be provided at the manufacturer's option. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings. A dipstick or a sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

G. Gear reducers which require the removal of parts or the periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.

H. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.

I. Adjustable Speed Drives.

1. Each mechanical adjustable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each adjustable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket type mounting will not be acceptable for variable speed drives.

J. V-Belt Drives.

1. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor.

1.10 SAFETY GUARDS.

A. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage thick or thicker galvanized, aluminum-clad sheet steel, or stainless sheet steel or from 1/2 inch mesh galvanized expanded metal, or pultrusion molded UV resistant materials. Each safety guard shall be reinforced or shaped to provide suitable strength to prevent vibration and deflection and shall comply with OSHA. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

1.11 ANCHOR BOLTS.

A. Equipment suppliers shall design and detail suitable anchor bolts for each item of equipment. Anchor bolts shall be designed for all operating conditions of the equipment, including wind and seismic loadings when applicable. Wind and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

B. Requirements for anchor bolt type, material, and minimum diameter shall be as indicated in the Anchorage in Concrete and Masonry section.

C. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete or masonry grout is placed.

D. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

1.12 EQUIPMENT BASES.

A. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches . Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be

anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in the Grouting section.

1.13 SPECIAL TOOLS AND ACCESSORIES.

A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

1.14 SHOP PAINTING.

A. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an epoxy or polyurethane enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

B. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

C. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the equipment manufacturer.

1.15 PREPARATION FOR SHIPMENT.

A. Equipment shall be prepared for shipment as specified in the Product Delivery Requirements section.

1.16 STORAGE.

A. Handling and storage of equipment shall be as specified in the Product Storage and Handling Requirements section.

1.17 INSTALLATION AND OPERATION.

A. Installation and operation shall be as specified in respective equipment sections and the Startup Requirements section.

1.18 OBSERVATION OF PERFORMANCE TESTS.

A. Where the Specifications require the presence of Engineer, initial tests shall be observed or witnessed by Engineer. Owner shall be reimbursed by Contractor for all costs of subsequent visits by Engineer to witness or observe incomplete tests, retesting, or subsequent tests.

1.19 PROGRAMMING SOFTWARE.

A. Programming software shall be provided for any equipment which includes a programmable logic controller (PLC) or other digital controller that is user-programmable.

B. The software shall be suitable for loading and running on a laptop personal computer operating with a Windows-based operating system.

C. A copy of the manufacturer's original operating logic program shall be provided for use in maintaining and troubleshooting the equipment.

D. Where multiple pieces of equipment, from the same or different vendors, use the same programming software, only one copy of the software need be provided.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

Section 01 65 00 - PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers packaging and shipping of materials and equipment.

1.2 PREPARATION FOR SHIPMENT.

A. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

B. Painted and coated surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted and coated surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Grease and lubricating oil shall be applied to all bearings and similar items.

1.3 SHIPPING.

A. Before shipping each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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Section 01 66 00 - PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers delivery, storage, and handling of materials and equipment.

1.2 DELIVERY.

A. Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Contract. These requirements also apply to any subsuppliers making direct shipments to the Site.

B. Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Contract before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, placed in operation and found to comply with all the specified requirements.

C. All items shall be checked against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay.

D. Delivery of portions of the equipment in several individual shipments shall be subject to review of Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

1.3 STORAGE.

A. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

B. Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and

reinforcing steel) shall be stored directly on the ground. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe, fittings, and valves may be stored out of doors, but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

C. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F . Electrical equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

D. Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be carefully followed by Contractor.

E. When required by the equipment manufacturer, moving parts shall be rotated a minimum of twice a month to ensure proper lubrication and to avoid metal to metal "welding". Upon installation of the equipment, Contractor shall, at the discretion of Engineer, start the equipment at one-half load for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

F. When required by the equipment manufacturer, lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment by Contractor at the time of acceptance.

G. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

H. In addition to the protection specified for prolonged storage, the packaging of spare units and spare parts shall be for export packing and shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

1.4 HANDLING.

A. Stored items shall be laid out to facilitate their retrieval for use in the Work. Care shall be taken when removing the equipment for use to ensure the precise piece of equipment is removed and that it is handled in a manner that does not damage the equipment.

B. During handling, carbon steel constructed material including chains, straps, and forks on lifting equipment shall not directly contact any equipment or material constructed of

stainless steel. It shall be the Contractor's responsibility to correct any carbon steel contamination of stainless steel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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SECTION 01 67 00 - METEOROLOGICAL AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SCOPE

A. Buildings, non-structural components and non-building structures shall be designed in accordance with this section. In the event of conflict with requirements in other sections, the more stringent criteria shall be followed.

1.2 DESIGN CRITERIA.

A. Buildings , non-structural components , non-building structures including anchorage of such items, shall be designed in accordance with the following criteria.

1. General Design Data		
	Building code and references	IBC 2021, ASCE 7-16 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”, AISC 360 “Specification for Structural Steel Buildings”, AISC 341 “Seismic Provisions for Structural Steel Buildings”
	Site elevation, above mean sea level (ft)	629.05
	Design flood elevation (ft)	611
	Design groundwater elevation (ft)	611
2. Wind Design Data		
	Basic (Ultimate) design wind speed, V (mph)	111
	Allowable Stress (Nominal) design wind speed, V_{asd} (mph)	86
	10 year mean recurrence interval (MRI) serviceability wind speed (mph)	72
	Exposure category	C
	Ground elevation factor, K_e	1.0
	Risk Category	III

3. Snow Design Data		
	Ground snow load, P_g (psf)	10
	Importance factor (snow loads), I	1.1
	Exposure factor (C_e)	1.0
	Thermal factor (C_t)	1.2
4. Ice Design Data		
	Nominal ice thickness, t (in)	1.0
	Concurrent wind speed, V_c (mph)	30
	Importance factor (ice loads – ice thickness), I_i	1.15
	Importance factor (ice loads – concurrent wind), I_w	1.0
5. Seismic Design Data		
	Mapped MCE short period spectral response acceleration, S_S	0.375 g
	Mapped MCE one second period spectral response acceleration, S_1	0.116 g
	Design short period spectral response acceleration, S_{DS}	0.375 g
	Design one second period spectral response acceleration, S_{D1}	0.183 g
	Risk Category	III
	Building Importance factor, I	1.25
	Building Seismic Design Category	C
	Non-Structural Components Importance Factor, I_P	As indicated in the Non-Structural Components Schedule
	Non-Structural Components Seismic Design Category	C
	Non-Building Structures Importance Factors, I	As indicated in the Non-Building Structure Schedule or in the applicable reference documents, whichever is greater.

1.3 WIND ANCHORAGE

A. Equipment that is to be located outdoors shall have anchor bolts designed for the effects of wind forces, as determined in accordance with ASCE 7, Chapters 26-31.

B. Design of anchorage shall be in accordance with the Anchorage in Concrete and Masonry section.

1.4 SEISMIC DESIGN

A. General.

1. Structural systems shall provide continuous load paths, with adequate strength and stiffness to transfer all seismic forces from the point of application to the point of final resistance.

B. Pre-Engineered Buildings

1. Pre-engineered buildings shall have sufficient strength and ductility to resist the specified seismic effects defined for buildings and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

2. "W" for buildings shall include the total dead load, the total operating weight of permanent equipment and the effective contents of vessels, and applicable portions of other loads, as required by the specified building code.

C. Non-Structural Components.

1. Non-structural components are architectural, mechanical, and electrical items that are permanently attached to and supported by a structure but are not part of the structural system, as indicated in Chapter 13 of ASCE 7. The Non-Structural Components Schedule identifies the components that require seismic design. The requirements of this paragraph are applicable only to the items listed in the Non-Structural Components Schedule.

2. General

a. Design of non-structural components shall be in accordance with all applicable provisions of ASCE 7, Chapter 13.
b. "W_p" shall include the total operating weight of the component or system, including, but not limited to, any insulation, fluids, and concentrated loads such as valves, condensate traps, and similar components.

3. Submerged Components

a. Components that are to be submerged in water shall be designed to withstand loads from the effects of water sloshing during the seismic event.
b. The calculation of the sloshing effects shall be in accordance with the latest edition of ACI 350.3.

4. Anchorage Design

a. Every component in the Non-Structural Components Schedule shall have its anchorage to the supporting structure designed in accordance with ASCE 7, Chapter 13.
b. Design of anchorage shall be in accordance with the Anchorage in Concrete and Masonry section.
c. Components shall be attached so that seismic forces are transferred to the structural system. Curbs that support roof-mounted equipment shall be designed to transfer forces from the equipment into the main structural roof members. All structural attachments shall be bolted, welded, or otherwise positively fastened. Frictional resistance due to gravity shall not be considered in evaluating the required resistance to seismic forces.

5. Component Design

a. Every component in the Non-Structural Components Schedule shall be designed for seismic conditions in accordance with ASCE 7, Chapter 13.
b. Components shall have sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes. Components shall be designed to be operable during and following a design level seismic event without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.
c. Seismic effects that shall be analyzed in the design of piping systems include the dynamic effects of the piping system, contents, and supports. The interaction between piping systems and the supporting structures, including other mechanical and electrical equipment, shall also be considered. Where pipe supports are to be designed by Contractor, as required by the Pipe Supports section, both the piping and support systems shall be designed to meet the applicable requirements of ASCE 7, Chapter 13.

6. Seismic Certification

a. Design of components and their anchorage shall be certified by one of the following methods.
    1) Analysis and design by a design professional registered in the state of the project. Certification by analysis shall be permitted only for nonactive components, and shall be based on seismic demand considering R_p/I_p equal to 1.0.

2) Shake table testing based upon a nationally recognized testing standard procedure, such as ICC-ES AC 156, acceptable to the authority having jurisdiction.
3) Experience data, based upon nationally recognized procedures acceptable to the authority having jurisdiction.

b. Components indicated in the Non-Structural Components Schedule to require special seismic certification shall be certified only by methods 2 or 3 above, except that certification for containment of hazardous materials may be by any of the three methods.

7. Construction Documents

a. Construction documents (fabrication or shop drawings) of non-structural components shall be sealed by a design professional that is registered in the state of the project.
b. Documents shall be sealed whether the basis for certification is analysis and design, shake table testing, or experience data.
c. The sealing method shall clearly indicate that the component and its anchorage have been designed for the code required seismic forces.

8. Submittals

a. The construction documents, structural design calculations, shake table certification, and experience data certification, as applicable, shall be submitted in accordance with the Submittal Procedures section.

D. Non-Building Structures

1. Non-building structures are the items described as such in Chapter 15 of ASCE 7. The Non-Building Structures Schedule identifies the items that require seismic design.

2. The requirements of this paragraph are applicable only to the items listed in the Non-Builiding Structures Schedule.

3. General

a. Design of non-building structures shall be in accordance with all applicable provisions of ASCE 7, Chapter 15.
b. Design of anchorage shall be in accordance with the Anchorage in Concrete and Masonry section.
c. "W" shall include the total dead load and shall also include all normal operating contents of tanks, vessels, bins, and piping.
d. Non-building structures shall provide sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes.

e. The seismic design of non-building structures shall provide sufficient stiffness, strength and ductility to resist the effects of seismic ground motions during the design level earthquake.
f. Non-building structures shall be designed to be operable during and following a design level seismic event, without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.

4. Submerged Structures

a. Structural elements that are submerged in water under normal operating conditions shall be designed to withstand loads from the effects of water sloshing during the seismic event.
b. The calculation of the sloshing effects shall be in accordance with the latest edition of ACI 350.3.

5. Construction Documents

a. Construction documents (fabrication or shop drawings) depicting all seismic force resisting elements of non-building structures shall be sealed by a design professional that is registered in the state of the project.

6. Submittals

a. The construction documents shall be submitted in accordance with the Submittal Procedures section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

Non-Structural Components Schedule			
Component	Applicable Specification Section	Importance Factor (I_p)	Special Seismic Certification Required
Filter Washwater Troughs	06 82 00	1.0	
Weir Plates and Scum Baffles	06 82 00	1.0	
FRP Doors and Frames	08 11 50	1.5	
Overhead Coiling Aluminum Doors	08 33 23.33	1.5	
Translucent Wall Panel System	08 45 00	1.0	
Louvers and Vents	08 90 00	1.0	
Vertical Diffusion Vane Pumps	43 24 13	1.0	
Multistage Centrifugal BlowersFloating Brush Aerator	46 51 13	1.0	
Liquid Chemical Feed Systems	46 33 00	1.5	x
Engine Generators	26 32 13	1.5	x
Panels, Consoles, and Appurtenances	40 67 11	1.0	
Fire Sprinkler Systems	21 13 00	1.5	
Plumbing	22 00 00	1.0	
Water Heaters	22 00 00	1.0	
HVAC Equipment	23 00 00	1.0	
Gas Vent Systems	23 00 00	1.0	
Air-Side HVAC Air Handling Units, Furnaces, Makeup Air Units, Fans, Heaters, and Other Mechanical Components Constructed of Sheet Metal Framing	23 00 00	1.0	
Ductwork Including Inline Components	23 00 00	1.0	
Refrigeration Systems	23 70 00	1.0	
Condensing Units, Heat Pumps, Packaged Air Conditioning Units and Heat Pumps and Other Mechanical Components Constructed of Sheet Metal Framing	23 70 00	1.0	
Lighting Fixtures	26 05 11	1.0	

Non-Structural Components Schedule			
Component	Applicable Specification Section	Importance Factor (I_p)	Special Seismic Certification Required
Lighting Panels	26 05 11	1.0	
Power Panels	26 05 11	1.0	
Surge Protection Device	26 05 11	1.0	
Separately Enclosed Motor Starters	26 05 11	1.0	
Separately Enclosed Manual Starters	26 05 11	1.0	
Control Stations	26 05 11	1.0	
Separately Enclosed Circuit Breakers	26 05 11	1.0	
Disconnect Switches	26 05 11	1.0	
Lighting and Auxiliary Power Transformers	26 05 11	1.0	
Power Centers	26 05 11	1.0	
Lighting Contactors	26 05 11	1.0	
Photoelectric Controls	26 05 11	1.0	
Relay Enclosures	26 05 11	1.0	
Adjustable Frequency Drives	26 29 24	1.0	
Common Motor Requirements for Process Equipment	40 05 93	1.0	
Switchboards	26 24 13	1.0	
600 Volt Class Motor Control Centers	26 24 23	1.0	
Bypass Isolation Automatic Transfer Switch	26 36 26	1.0	
Lightning Protection Systems	26 41 13	1.0	
Fire Detection and Alarm Systems	28 31 16	1.5	
Fire Detection and Signaling System	28 31 19	1.5	

Note: Some specification sections listed in the Non-Structural Components Schedule cover multiple items. Within those sections, some components may be exempt from seismic design based on their weight and/or their height above the floor. Reference ASCE 7, Paragraph 13.1.4 for specific conditions of the exemptions. Some distribution systems such as conduit, cable tray, raceways, duct systems, and piping and tubing

systems may also be exempt from seismic design based on their loads and support mechanisms as indicated in their respective paragraphs in ASCE 7, Chapter 13.

Non-Building Structures Schedule		
Structure	Applicable Specification Section	Importance Factor (I)
Fiberglass Reinforced Plastic Chemical Storage Tanks	43 41 45.13	1.5

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Section 01 68 00 - EQUIPMENT AND VALVE IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and installation of nameplates and tags for identification of equipment, valves, panels, and instruments.

1.2 GENERAL.

A. Except as otherwise specified in equipment, valve, and instrumentation sections, nameplates and tags shall be as specified herein. Nameplates or tags shall be provided for all equipment, valves, operator interfaces, control and electrical panels, cabinets, instruments, and instrument racks that have been named and/or tagged on the Drawings.

1.3 SUBMITTALS.

A. Drawings and Data

1. Drawings and data shall be submitted in accordance with the requirements of the Submittals Procedures section for each type of tag provided including materials, colors, sizes, letter sizes, and installation instructions.

PART 2 - PRODUCTS (NOT USED)

2.1 EQUIPMENT NUMBER PLATES.

A. All equipment tagged on the drawings, except for submerged equipment shall be provided with number plates bearing the equipment tag number identified on the Drawings.

B. Number plates shall be bevelled, 1/8th inch thick laminated black phenolic plastic engraving stock with white core. Lettering on number plates shall be capitalized block letters ¾ inch high.

C. Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around.

D. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

E. Number plates shall be attached with stainless steel panhead screws, rivets, or drive screws.

F. When a number plate cannot be installed due to the physical size, space, or mounting surface geometry of the equipment, the Contractor shall provide a 12 gauge stainless steel tag with engraved or imprinted equipment tag number. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges and shall be fastened to the equipment with stainless steel mechanical fasteners or with a stainless steel chain.

2.2 EQUIPMENT INFORMATION PLATES.

A. Equipment shall be provided with engraved or stamped equipment information plates securely affixed with mechanical fasteners to the equipment in an accessible and visible location.

B. Equipment information plates shall be in addition to the number plates specified.

C. Equipment information plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data.

D. Equipment information plates listing the distributing agent only will not be acceptable.

2.3 VALVE AND GATE TAGS.

A. Temporary Tags.

1. Each valve and gate with an identifying number indicated on the Drawings or listed in the valve or gate schedule, shall be tagged or marked in the factory with the identifying number.

B. Permanent Tags.

1. All valves and gates, except buried or submerged valves, that have been assigned a number on the Drawings or in the valve or gate schedule, shall be provided with a permanent number plate.

2. Tags shall be permanently attached to valves and gates with stainless steel mechanical fasteners or with stainless steel chains. Numerals shall be ¾ inch 20 mm high and shall be black baked enamel on an anodized aluminum plate.

C. All buried valves shall be tagged with a brass plate cast into a 6-inch by 6 inch concrete pad at grade next to the valve box. The valve number shall be engraved in the brass plate with lettering and numerals at least 1 inch high.

2.4 PANEL NAMEPLATES.

A. Nameplates shall be provided on the face of each panel and cabinet. Panel identification nameplates shall be mounted at the top of the panel shall include the panel descriptive name and tag number as indicated on the Drawings, in two or three lines of text. Lettering shall be ¾ inch high.

B. Nameplates for devices mounted on or in the panel shall be inscribed with the text as indicated on the Drawings. Where nameplate information is not indicated on the Drawings, inscriptions shall be in accordance with information in the supplier's submittal drawings as guided by information in the relevant specification section. Panel device nameplates shall have engraved letters 3/16 inch high.

C. Nameplate material and size shall be as specified above for equipment number plates. Nameplates shall be secured to the panel with stainless steel panhead screws.

2.5 INSTRUMENT TAGS.

A. Temporary Tags.

1. Where instruments are not provided with permanent tags furnished from the factory, instruments shall be tagged or marked in the factory with the instrument tag number indicated on the Drawings.

B. Permanent Tags.

1. Instruments shall be tagged with the instrument tag number indicated on the Drawings. Tags shall be 12 gauge stainless steel with engraved or imprinted symbols. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges, and shall be fastened to the instrument with stainless steel mechanical fasteners or with a stainless steel chain.

PART 3 - EXECUTION (NOT USED)

End of Section

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SECTION 01 73 19 - EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers general installation requirements of new equipment units that have been purchased by Contractor as part of this Work. Equipment specific installation requirements are covered in the equipment sections.

1.2 GENERAL.

A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Any equipment identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment be purchased are available.

C. Coordination.

1. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services furnished by others.

2. Submittals for equipment furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

3. Flanged connections to equipment including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section.

1.3 DELIVERY, STORAGE, AND HANDLING.

A. Storage.

1. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with the Product Storage and Handling Requirements section until installed in the Work.

2. Equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on or come into contact with the ground, grass, or any other type of vegetation.

3. Contractor shall keep the equipment dry at all times

PART 2 - PRODUCTS

2.1 MATERIALS.

A. Materials shall be as follows:

1. Grout: As specified in the Grouting section.

2. Anti-Seize thread lubricant for SS bolts: As specified in the Anchorage in Concrete and Masonry section.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results as specified in the Startup Requirements section.

B. Each equipment unit shall be leveled, aligned, and shimmed into position. Installation procedures shall be as recommended by the equipment manufacturer and as required herein. Shimming between machined surfaces will not be permitted.

C. Anti-seize thread lubricant shall be liberally applied to the threaded portion of all stainless steel bolts during assembly. For equipment installed in drinking water facilities, the anti-seize lubricant shall meet requirements of ANSI/NSF-61 and the applicable requirements of ANSI/NSF 600.

D. When specified in the equipment sections, the equipment manufacturer will provide installation supervision and installation checks. For installation supervision, the manufacturer’s field representative will observe, instruct, guide, and direct Contractor's erection or installation procedures as specified in the equipment specifications. For installation checks, the manufacturer’s field representative will inspect the equipment installation immediately following installation by Contractor, and observe the tests indicated in the Startup Requirements section. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

E. All equipment shall be protected after installation, prior to final acceptance by Owner. Protection provisions shall be as recommended by the manufacturer, and shall include provisions to prevent rust, mechanical damage, and foreign objects entering the equipment.

3.2 STARTUP AND TESTING.

A. Startup requirements, and tests associated with startup shall be as indicated in the Startup Requirements section. Other field tests shall be as indicated in the specific equipment sections. Startup and tests required shall occur in the order listed in the following paragraphs. Tests shall not begin until any installation supervision and installation checks by the equipment manufacturer have been completed, except where noted below.

B. Preliminary Field Tests.

1. Preliminary field tests shall be conducted on all equipment by Contractor as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's representative will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

C. Field System Operation Tests.

1. Field system operation tests shall be conducted on all equipment by Contractor as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's service personnel will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

D. Field Demonstration Tests.

1. Field demonstration tests will be conducted by the equipment manufacturer on equipment as indicated and as specified in the equipment sections.

E. Field Performance Tests & Distribution Tests.

1. Field performance tests or distribution tests will be conducted by the equipment manufacturer on equipment as indicated and as specified in the equipment sections.

F. Field Baseline Performance Tests.

1. Field baseline performance tests shall be conducted by Contractor on the equipment indicated in the equipment sections, and the tests shall be performed as indicated. When indicated in the equipment sections, the equipment manufacturer will participate in these tests. This test shall not be considered an

acceptance test, but rather a test to determine initial performance curves and efficiency just prior to the equipment entering service.

End of Section

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers administrative and procedural requirements for construction, demolition, and land-clearing (CDL) waste management and includes:

1. Salvaging nonhazardous **[**demolition **[** and **]**construction**]** waste.

2. Recycling nonhazardous **[**demolition**[** and **]**construction**]** waste.

3. Disposing of nonhazardous **[**demolition**[** and **]**construction**]** waste.

B. Hazardous Environmental Conditions are covered in the Project Requirements section.

C. Contractor shall comply with hauling and disposal regulations of authorities having jurisdiction.

D. The waste management plan shall be administered by an experienced waste management coordinator.

1.2 GENERAL.

A. Contractor shall develop a waste management plan to divert from landfills or incineration, a minimum of **[**50**][**75**][***Insert number***]** percent by weight of total non-hazardous waste generated by the Work**[** associated with the portion of the Project within the LEED site boundary indicated on the Drawings. Contractor shall document construction waste management for the Work within the LEED site boundary separately from all other Work on Site**]**. The diverted waste shall be salvaged or recycled.

B. Work outside the LEED site boundary shall follow the requirements specified herein. The salvage/recycling calculation for the portion of the project within the LEED site boundary shall be made separately from the portion of the project outside of the LEED site boundary.

C. The following is a list of materials that can commonly be salvaged and/or recycled. The Contractor is advised to consider these materials while developing the CDL waste management plan to divert the specified quantity of waste.

1. Demolition Waste:

a. Asphalt paving
b. Concrete
c. Concrete reinforcing steel

d. Masonry
e. Lumber and wood products
f. Structural and miscellaneous steel and metals
g. Roofing
h. Insulation
i. Doors and windows
j. Glass
k. Gypsum board
l. Acoustical tile and panels
m. Carpet and pad
n. Cabinets and furniture
o. Plumbing fixtures
p. Piping, valves, and supports
q. Mechanical equipment
r. Refrigerants
s. Ductwork
t. Conduit and wire
u. Electrical equipment and fixtures
v. **[***Insert other materials***]**

2. Construction Waste:

a. Masonry and CMU
b. Lumber and wood products
c. Metals
d. Roofing
e. Insulation
f. Carpet and pad
g. Gypsum board
h. Piping
i. Electrical conduit
j. **[***Insert other materials***]**

D. One hundred percent of uncontaminated packaging materials shall be salvaged or recycled including, but not limited to paper, cardboard, plastic sheet and film, polystyrene, crating materials, and plastic containers.

1.3 SUBMITTALS.

A. General Requirements

1. The required plans and reports shall be submitted in accordance with the Submittals Procedures section.

B. CDL Waste Management Plan

1. Contractor shall submit the final draft of the CDL Waste Management Plan within 14 days of the Preconstruction Conference. Submittal shall include

responsibilities and qualifications of the waste management coordinator and refrigerant recovery technician, if refrigerant recovery is included in the Project.

C. Waste Diversion Progress Reports

1. Waste Diversion Progress Reports shall be submitted with each Application for Payment. **[**Separate reports shall be submitted for demolition and construction waste. **]**Reports shall include the following information for each type of waste:

   a. Total quantity of waste
   b. **[**Quantity of waste salvaged **]**
   c. Quantity of waste recycled
   d. **[**Total quantity of waste recovered (salvaged plus recycled)**]**
   e. Total quantity of waste recovered **[**(salvaged plus recycled) **]**as a percentage of total waste

2. The report shall total the **[**salvage plus **]**recycled quantities, total quantity of waste, and total percent **[**salvaged and **]**recycled. Figures shall be both for the period covered by the Application for Payment and to date totals.

3. The report shall be accompanied by copies of:

   a. Records of donations and sales to verify material has been donated or sold, and whether individual/organization is tax exempt.
   b. Records from recycling processing facilities include manifests, weight tickets, receipts, and invoices for recycled materials. Where separation is performed by the recycling facility, verification of the percent diverted from landfill shall be submitted.
   c. Records from waste processing facilities including manifests, weight tickets, receipts, and invoices for materials disposed.

D. Qualifications Data

1. Within 30 days of Notice to Proceed, Contractor shall also submit qualification data for the waste management coordinator and refrigerant recovery technician.

E. End of Project Waste Diversion Report

1. Prior to substantial completion, Contractor shall submit the following:

   a. End of Project Waste Diversion Report showing to date recycling**[**, salvage ,**]** and total waste figures as specified above for the Waste Diversion Progress Reports.

F. LEED Letter Template

1. LEED letter template for Credit MR 2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

G. Refrigerant Recovery Statement

1. Statement of refrigerant recovery signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Statement shall include name and address of technician and date(s) refrigerant was recovered.

1.4 QUALITY ASSURANCE.

A. The management of CDL waste shall be conducted in accordance with applicable laws and regulations.

B. The waste management coordinator shall be a professional that is LEED accredited by the US Green Building Council.

C. The waste management coordinator shall have experience coordinating waste management on a project of equal or greater value than **[**the LEED portion of **]**this Project.

D. The waste management coordinator may also serve as LEED coordinator.

E. The refrigerant recovery technician shall be certified by an EPA-approved certification program.

1.5 PRECONSTRUCTION CONFERENCE.

A. Contractor shall review the proposed methods and procedures for waste management at the Preconstruction Conference. The review shall include, but not be limited to the following:

1. Draft CDL waste management plan.

2. Qualifications of the Contractor's proposed waste management coordinator and refrigerant recovery technician.

3. Salvage and recycling logistics including separation procedures and container availability.

4. Identification of recycling centers and vendors for salvaged and recycled waste, and procedures for collection and hauling of waste to recycling and disposal facilities.

5. Requirements for documentation.

6. Subcontractor management with respect to waste management.

7. Waste management for each trade.

8. Review of applicable **[**LEED requirements and **]**laws and regulations.

1.6 CDL WASTE MANAGEMENT PLAN.

A. Contractor shall develop a CDL waste management plan in accordance with laws and regulations where applicable, which identifies implementation protocols and parties responsible for implementation. The plan shall include management of CDL waste for **[**the entire Project. **][**the portion of the Project within the LEED site boundary. **]**

B. The plan shall include separate sections for demolition and construction waste.

C. Quantities shall be indicated by weight or volume, with the same units of measure used throughout the plan.

D. The CDL waste management plan shall include, but not be limited to the following:

1. Type and quantities of CDL waste expected to be generated.

2. Proposed methods for CDL waste salvage, reuse, recycling, and disposal during demolition including, but not limited to one or more of the following:

a. Contracting with a deconstruction specialist to salvage materials,
b. Selective salvage as part of demolition contractor's work,
c. Reuse of materials on-site or sale or donation to a third party,
d. Projected salvage rate for each salvage item or material,
e. Off-site or on-site sorting of materials for recycling.

3. Proposed methods for salvage, reuse, recycling, and disposal during construction including, but not limited to, one or more of the following:

a. Requiring subcontractors to haul their CDL waste to a recycling facility,
b. Contracting with a recycling hauler to haul recyclable CDL waste to an approved recycling or material recovery facility,
c. Processing and reusing materials on-site,
d. Self-hauling to a recycling or material recovery facility,
e. Projected recycling rate for each material type,
f. Off-site or on-site sorting of materials for recycling.

4. Name of the recycling or material recovery facilities that will receive CDL waste.

5. Handling and transportation procedures including method for on-site separation of recyclable waste, where applicable.

6. Communication and education plan for personnel of the Contractor, subcontractors, and the Engineer. Owner may elect to participate.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION.

A. The CDL waste management plan as accepted by the **[**Engineer**][**Consulting Engineer**]** shall be implemented. Contractor shall provide handling, containers, storage, signage, transportation, and other items as required to implement the CDL waste management plan for the duration of the Contract.

B. Contractor shall engage or designate a waste management coordinator to be responsible for implementing, monitoring, and reporting status of the CDL waste management plan. The coordinator shall be present at the Project site full time for the duration of the Project.

C. Contractor shall train workers, subcontractors, and suppliers on proper waste management procedures as appropriate for the Work occurring at the Project site. The waste management plan shall be distributed to everyone concerned within three days of the return of the accepted plan. Contractor shall review plan procedures and locations established for salvage, recycling, and disposal with each entity. The Contractor's training and communication shall include:

1. Discussion of waste prevention and recycling activities at each regularly scheduled progress meeting.

2. Provide a copy of the CDL Waste Management Plan and a tour of the recycling areas to each subcontractor that comes on-site.

3. Clear identification of each type of waste container with acceptable and unacceptable materials posted for each container.

D. Materials to be salvaged, recycled, reused, donated, or sold shall be protected from the weather where weathering will degrade the material.

3.2 SALVAGING DEMOLITION WASTE.

A. Salvaged items for reuse in the Work shall be cleaned stored in an protected and orderly manner in a secure area until installation. Salvaged items shall be installed in accordance with the requirements for new materials and equipment.

B. Salvaged Items for Owner's use shall be cleaned, packed or crated and stored in a secure area until delivery to the Owner. The items shall be transported to an **[**on**][**off**]**-site storage area designated by the Owner. Items shall be protected from damage during transport and storage.

3.3 RECYCLING **[**DEMOLITION**[** AND **]**CONSTRUCTION **]** WASTE.

A. Paper and beverage containers used by on-site workers shall be recycled.

B. The list below of recycling receivers and processors is provided for information only. Contractor is responsible for identifying recycling facilities to be used in the Work.

1. *Insert names and telephone numbers*

C. Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall **[**accrue to Contractor**][**accrue to Owner**][**be shared equally by Owner and Contractor**]**.

D. Where source separation is elected by the Contractor, recyclable waste shall be separated by type at the Project site to the maximum extent practical, and placed into appropriately marked containers. Containers and stockpiles shall be inspected for contamination and contaminated materials removed.

E. Recyclable waste shall be stored away from the construction area, and outside of the drip line of trees. Recyclable waste shall be removed from Owner's property and transported to a recycling receiver or processor.

3.4 SITE CLEARING DEBRIS AND EXCAVATION MATERIAL.

A. All site clearing debris shall be hauled off-site to a composting facility or shall be chipped and used on the Site as landscape mulch where indicated on the Drawings or permitted by the Engineer.

B. Excavated materials shall be used on-site unless off-site disposal is permitted by the Engineer.

3.5 DISPOSAL OF WASTE.

A. Waste materials to be disposed shall be removed from the Site and legally dispose of in a landfill or incinerator acceptable to authorities having jurisdiction. Waste materials that are to be disposed of shall not be accumulated on-site, and are to be removed and transported in a manner that will prevent spillage.

End of Section

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SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 Substantial Completion Procedures.

A. Procedures for achieving Substantial Completion on the Project shall be as indicated in the Division 00 Sections and as indicated below.

B. Contractor's List of Incomplete Items:

1. Contractor shall prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

C. Submittals

1. General.

a. Prior to Substantial Completion: Contractor shall complete the submittals listed in this section a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion.

2. Certificates of Release

a. Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

3. Division 00 and 01 Closeout Submittals

a. Submit closeout submittals specified in other Division 00 or Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.

4. Other Closeout Submittals

a. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

5. Maintenance Material Submittals

a. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.

6. Schedule of Maintenance Material Items

a. Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner’s signature for receipt of submittals.

7. Testing, adjusting, and balancing records.

8. Sustainable design submittals not previously submitted.

9. Changeover Information

a. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

1.2 Procedures

A. Prior to Substantial Completion: Contractor shall complete the following activities a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion:

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified elsewhere.

6. Advise Owner of changeover in utility services.

7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Complete final cleaning requirements.

10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

1.3 Inspection

A. Contractor shall submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests.

B. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

C. Contractor shall request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

D. Results of completed inspection will form the basis of requirements for final completion.

1.4 Final Completion Procedures.

A. Procedures for achieving Final Completion on the Project shall be as indicated in the Division 00 Sections and as indicated below.

B. Submittals

1. General

a. Prior to Final Completion: Contractor shall submit the following to Engineer before requesting final inspection for determining final completion:

2. Final Application for Payment

a. Submit a final Application for Payment according to Progress Payment Procedure Section.

3. List of Incomplete Items

a. Certified List of Incomplete Items: Submit certified copy of Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

4. Certificate of Insurance

a. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

5. Pest-control final inspection report.

6. Final completion photographic documentation.

1.5 Inspection

A. Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

B. Contractor shall request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 Submittal Of Project Warranties.

A. Submittals

1. General.

a. Project Warranty information and documentation shall be submitted as indicated in the Division 00 Sections and as indicated below.
b. Contractor shall submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
c. Partial Occupancy: Contractor shall submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

2. Warranty Documentation

a. Contractor shall organize warranty documents into an orderly sequence based on the table of contents of Project Specifications.
b. Where warranty documentation is electronic, Contractor shall submit warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
c. Where warranty documentation is in hard copy format, Contractor shall submit warranties and bonds as follows:
    1) Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
    2) Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
    3) Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

1.7 Final Cleaning And Repair Of Work.

A. In addition to any specific cleaning or repair work identified in Lists of Incomplete Items for Substantial Completion or Final Completion, Contractor shall perform the following general final cleaning and repair of work:

1. General

    a. Contractor shall perform final and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

2. Cleaning

    a. Contractor shall employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

3. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
q. Leave Project clean and ready for occupancy.

B. Pest Control

1. Contractor shall complete all work and submit documentation to show compliance with pest control requirements specified elsewhere. Contractor shall prepare a written report documenting compliance.

C. Construction Waste Disposal:

1. Contractor shall complete all work and submit documentation to show compliance with waste disposal requirements in the Construction Waste Management and Disposal Section.

D. Repair and Restoration Work

1. Contractor shall complete repair and restoration work before requesting inspection for determination of Substantial Completion.

2. Contractor shall repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

3. Contractor shall remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

4. Contractor shall touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

5. Contractor shall replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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Section 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION.

A. This section contains requirements for training the Owner's personnel in the proper operation and maintenance of the equipment and systems installed under this contract.

1.2 GENERAL.

A. Where indicated in the Equipment Schedule section and as required by the specifications, the manufacturer's representative shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.3 SUBMITTALS.

A. General

1. The following information shall be submitted to the Engineer in accordance with the provisions of the Submittals section. The material shall be submitted not less than 4 weeks prior to the provision of training.

2. Lesson plans, training manuals, handouts, visual aids, and other reference materials for each training session to be conducted by the manufacturer's representatives.

3. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

2.1 GENERAL.

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date schedule for the individual training session.

2.2 LOCATION.

A. Training sessions shall take place at the site of the work at a location designated by the Owner.

2.3 LESSON PLANS.

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of the visual aids to be utilized during the sessions. Each plan shall contain time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids and reference materials shall be the property of the Owner and shall be suitable bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids, and reference materials at least 1 week prior to each training session.

2.4 FORMAT AND CONTENT.

A. Each training session shall include classroom and time at the location of the subject equipment or system. As a minimum, training sessions shall cover the following subjects for each item of equipment or system:

1. Familiarization

a. Review catalog, parts lists, drawings, etc, which have been previously provided for the plan files and operation and maintenance manuals.
b. Guided inspection of the subject equipment.
c. Demonstration of the subject equipment and how operation in accordance with the specified requirements.

2. Safety

a. Review and demonstration of safety procedures and related documentation.
b. Inspection and discussion of hazardous components of the subject equipment.

3. Operation

a. Review of subject equipment operations literature and theory of operation.
b. Overview of equipment operation and function.
c. Explanation and demonstration of all modes of operation including start up, shut down, normal, and emergency operation, and manual and automatic operation through the plant control system.
d. Explanation of all hardwired interlocks.

e. Explanation and demonstration of equipment related valves and their purpose.
f. Explanation of all equipment related instruments including primary element, instrument indicator, purpose, and interpretation of information.
g. Check out of Owner's personnel on proper use of the equipment.

4. Preventive maintenance

a. Review preventative maintenance documentation and discussion of maintenance require at various intervals; e.g. daily, weekly, monthly, annually.
b. Demonstrate performance of each preventive maintenance task.
c. Identification of indicators of equipment problems.
d. Discussion of corrosion protection and lubrication requirements.
e. Requirements for periodic exercise of equipment and demonstration of equipment exercise where required.
f. Identification of inspection points and demonstration of inspection covers removal and routine disassembly and assembly of equipment.

5. Corrective Maintenance and Equipment Repair

a. Discussion of common repairs and identification of special problems.
b. Explanation and demonstration of equipment inspection and troubleshooting.
c. Demonstration of calibration procedures.
d. Demonstration of repair procedures where practical.

6. Parts

a. Discussion of the parts list and ordering of parts.
b. Review of spare parts provided with the equipment and identification of other recommended spare part.

7. Local Representatives

a. Name, address, telephone of local representative.
b. Review of contact information for providers of routine and emergency repair and operational assistance.

8. Operation and Maintenance Manuals

a. Review of O&M manual content and organization.
b. Update O&M material as required.

2.5 VIDEO RECORDING.

A. The Contractor shall record each training session and shall give the Owner exclusive rights to each training session recording. The Contractor shall advise all manufacturers providing training sessions that the material will be recorded.

PART 3 - EXECUTION

3.1 General

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled so that training is performed when equipment is available for operation. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of class scheduled for any one day. Concurrent classes will not be permitted.

End of Section

Section 01 91 00 - Commissioning

PART 1 - GENERAL

1.1 SCOPE.

A. This section includes the requirements for startup and testing all items of equipment and systems that form a part of this Contract.

B. The purpose of this section is to define the requirements for bringing individual equipment, systems, and facilities online and for proving proper operation and performance of that Work.

C. Contractor is required to develop, submit, and maintain detailed plans, including designation of management and staff, for these activities as specified herein.

D. Additional requirements such as disinfection and training are specified in other sections.

E. The Contractor is also required to startup, test, and commission equipment procured by the Owner and assigned to the Contractor. The Contractor shall refer to the Procurement Documents furnished by Owner and coordinate with the Supplier of the equipment regarding startup and testing activities.

F. The startup, testing, and commissioning services referenced or specified herein include the following:

1. Startup and Testing

    a. Startup checks
    b. Functional testing

2. Functional acceptance testing

3. Commissioning

4. Operation acceptance testing

5. Performance testing

G. Definitions.

1. Startup and Testing is the transitional phase between completion of construction and start of commissioning and includes the following:

    a. Pre-Startup Activities and Checks - Inspections, tests and other activities necessary to determine that equipment, systems and subsystems have been properly manufactured and installed. Pre-startup activities shall include an audit of all factory testing of equipment and compiling the results for comparison to startup and commissioning testing.
    b. Functional Testing – Initial limited operation of equipment, to demonstrate capability of installed components to perform their intended functions, respond to controls, and safely interface with external systems, followed by operation of individual systems in manual and automatic mode to test full functionality of individual systems.
    c. Commissioning - The establishment of the treatment processes for the plant.
    d. Operational acceptance testing - Continuous testing of complete the treatment processes under specified operating conditions in accordance with the technical Specifications and applicable regulations to demonstrate proper performance of the facility.
    e. Performance testing - When specified, continuous testing in accordance with the requirements of the Contract Documents.

1.2 GENERAL.

A. The Contractor shall be responsible for and furnish all labor, materials, instruments, incidentals, and equipment required for startup, testing, and commissioning.

B. Temporary facilities required to carry out the specified testing, including temporary pipe, pumps, and other appurtenances, shall be furnished and installed, and removed when no longer required for startup, testing, and commissioning. Refer to the Temporary Facilities section for requirements concerning water and power for startup and testing.

C. Chemicals required for startup and testing shall be provided by the Contractor except as otherwise specified herein.

D. Wastewater, including treated or test water that cannot be delivered to the systemfor any reason, shall be disposed of at the expense of the Contractor, in a manner acceptable to the Owner, and in accordance with all laws, regulations**,** and permits.

E. Startup and testing shall be conducted during normal working hours during the workweek of Monday through Friday, unless otherwise approved by the Owner.

F. Where continuous long-term testing is required, testing may continue over the weekends and holidays with prior approval from the Owner.

1.3 Constraints.

A. Startup and testing shall be conducted in a manner that does not compromise quality of treated products released from the facility.

B. Any startup and testing activities affecting operation of the existing facilities shall be coordinated with the Owner and shall be shown on the Progress Schedule. The Owner will cooperate with the Contractor to the extent possible, but will have sole authority in decisions affecting existing operations.

C. The minimum constraints for startup and testing include the following:

1. *Insert constrains*

2.

1.4 STARTUP MANAGER, STARTUP TEAM, AND MANUFACTURER'S FIELD SERVICES REPRESENTATIVES.

A. The Contractor shall maintain a dedicated startup team led by a startup manager. The individual to be designated as startup manager shall be identified within 45 days of the Notice to Proceed and will be reviewed by Owner and Engineer. Once accepted, the Contractor shall not change the startup manager throughout the full period of performance of the Work without written permission of the Owner. Once engaged in the Project, the startup manager shall attend regular construction progress meetings. No startup activities shall begin until the startup manager has arrived at the jobsite.

B. The startup manager shall be on Site full time at least 30 days prior to any field startup and testing activities and shall remain on site until all startup, testing, and commissioning activities are complete.

C. Startup Manager.

1. The startup manager shall be a startup and testing expert with a minimum of 5 years of experience starting up equipment and systems of similar type, size, capacity, and complexity to the equipment and systems included in this Project. The startup manager shall have the necessary experience to fully understand all startup requirements, to manage the Contractor's resources providing the startup services, and to prepare all startup documentation, as specified. The startup manager's assigned duties and responsibilities are those specifically related to planning, supervising, and executing startup activities and shall include, but shall not be limited to the following:

a. Coordinating all testing and startup activities.

b. Preparing all startup and field testing plans, documentation, and forms.
c. Liaising between the Contractor, Engineer, and Owner for all startup and testing activities.
d. Developing a comprehensive schedule for all startup activities and providing regular schedule updates. The startup and testing schedule shall be incorporated into the Progress Schedule.
e. Scheduling and leading startup, testing, and commissioning planning meetings.
f. Conducting coordination meetings during startup, testing, and commissioning at least weekly.
g. Coordinating manufacturers' services and their certification of proper installation and/or operation of equipment as required by the Specifications.
h. Overseeing and administering all startup, testing, and commissioning activities, including either direct participation in the activities and/or oversight and monitoring of activities. It shall be the startup manager's responsibility to assure that all tests have been completed in accordance with accepted testing procedures.
i. Ensuring readiness for and coordinating maintenance, repair, and adjustment of equipment and systems during startup testing, and commissioning.
j. Conducting or overseeing pre-test checks to ensure readiness for testing.
k. Verify all piping hydrostatic testing and flushing has been completed prior to field testing connected equipment.
l. Ensuring all testing equipment is in proper working order and has been calibrated to appropriate standards.
m. Developing safe work policies and procedures including lockout/tagout procedures and personal protective equipment policies, that will be followed during all field startup and testing activities. At a minimum the Contractor shall comply with OSHA and the Owner's established safety guidelines. It shall be the startup manager's responsibility to assure all safety procedures are followed at all times.
n. Reviewing and approving all equipment training sessions prior to submission to Engineer, to assure that the training is compliant with the requirements of the Specifications and includes all applicable operation, maintenance, safety, functional, performance, and startup and testing information.
o. Organizing teams made up of qualified representatives of Suppliers, Subcontractors, and others, as appropriate, to efficiently and expeditiously startup and test the equipment and systems installed and constructed under this Contract. The objective of this program shall be to demonstrate to the Engineer and Owner that the structures, systems, and equipment constructed and installed under this Contract meet all performance requirements and the facility is ready for operation as intended. In addition, the testing program shall produce baseline operating conditions for the Owner to use in a preventive maintenance program.

p. Ensuring the development and maintenance of records documenting all startup, testing, and commissioning activity. The records shall be organized by major process system into organized files/binders and turned over to the Owner prior to applying for final payment. Testing records shall be accessible to the Engineer and Owner at all times to allow monitoring of the progress.

q. Ensuring the startup team is equipped and ready to make emergency repairs and adjustments to equipment installed and modified as part of the Project.

r. Scheduling and conducting a one day workshop with the Owner and Engineer to resolve submittal review comments to the Contractor's startup, testing, and commissioning plan submittal.

s. Notifying the Owner and all respective equipment manufacturers at least 21 days prior to the date when each equipment system is scheduled for pre-startup activities and checks.

t. Organize International Electrical Testing Association (NETA) acceptance testing in accordance with the Electrical Equipment Installation section.

D. Startup Team.

1. The startup team shall include the startup manager and all staff deemed necessary for successful completion of startup, testing, and commissioning. This will typically include engineers, major equipment vendors, operators, and representatives from the Instrumentation and Control System Supplier. Additional trade representatives may be included as project requirements dictate.

E. Manufacturer's Field Services Representative.

1. The manufacturers shall provide a technically qualified field-service representative for the installation, startup, and testing of equipment furnished, as specified in the equipment sections.

2. The manufacturer shall submit qualifications and experience records for all key personnel to be involved in startup activities.

3. The manufacturer's field services representative shall be employed full-time in installation, startup, and testing of similar equipment and facilities and work directly for the manufacturer.

4. The representative shall have conducted startup activities similar to those required herein on at least two other projects of similar complexity.

5. The Owner or Engineer shall have the right to reject the manufacturer's field services representative at any time, for immediate replacement by the manufacturer, if the accepted qualifications are not representative of the actual

experience or abilities of the representative, as determined by the Owner or Engineer.

1.5 SUBMITTALS.

A. Startup Manager Qualifications

1. Startup manager's qualifications and past project experience including contact names, addresses and current telephone numbers of owner representatives that can be used to verify the accuracy of the information. Submittal shall be made at the preconstruction conference.

B. Manufacturer Representative Qualifications

1. Manufacturers' field services representative's qualifications and past project experience including contact names, addresses and current telephone numbers that can be used to verify the accuracy of the information. Qualification submittals shall be made 3 weeks before the manufacturer's representative is scheduled to be on Site.

C. Installation Certifications

1. Manufacturer's certification of proper installation of all equipment as specified in the equipment sections.

D. Plans and Schedules

1. Equipment and system startup, testing, and commissioning plans and schedule in accordance with the requirements of this section. Startup manager shall coordinate with Subcontractors and include their information in the startup and testing plan.

E. Field Calibration Results

1. Unless otherwise specified in the equipment sections, preliminary copies of field calibration results. Submittal shall be made prior to the start of each test for associated systems.

F. Daily logs.

G. General

1. Submittals shall be provided in accordance with the requirements of the Submittals Procedures section.

1.6 STARTUP AND TESTING REQUIREMENTS.

A. Startup Checks.

1. Prior to field testing of all equipment, the Contractor shall perform the following:

a. Inspect and clean equipment, devices, and connected piping so they are free of foreign material.
b. Lubricate equipment in accordance with manufacturer's instructions.
c. Turn rotating equipment by hand.
d. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
e. Test and commission related electrical system components in accordance with the requirements specified in the Electrical and the Electrical Equipment Installation sections.
f. Calibrate all instruments associated with the equipment.
g. Check for proper rotation, adjustment, alignment, balancing, mechanical and electrical connections, and any other conditions that may damage or impair equipment from functioning properly.
h. Inspect and verify proper anchorage.
i. Obtain manufacturer's certification of proper installation where specified in the equipment sections.

2. All equipment shall be confirmed ready to test by the Engineer based on the following:

a. Acceptance of Contractor's startup and testing plan.
b. Notification in writing by the startup manager that each piece of equipment or system is ready for testing.
c. Verification by the Engineer and Owner that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.
d. Cleanliness of equipment, devices, and connected work.
e. Adequate completion of work adjacent to or interfacing with equipment to be tested.
f. Confirmation of manufacturer's representative's availability to assist with testing, where specified, and satisfactory fulfillment of all other manufacturers' responsibilities as specified.
g. Engineer's inspection of all related civil construction, mechanical, and electrical installations.
h. Confirmation of completion of acceptable testing of all adjacent piping, duct work and other affected Work.

B. Functional Testing.

1. All startup checks shall be completed prior to functional testing. Functional testing shall be in accordance with relevant standards and in accordance with instructions of the manufacturers.

2. Ancillary and/or temporary facilities necessary to recycle, control, or discharge water, air, chemical, or gas from facilities being tested, shall be operational.

3. Functional testing shall include the functional operation of each piece of equipment. All moving parts of equipment and machinery shall be tested and adjusted so that they move freely and function satisfactorily. Functional testing shall demonstrate correct operation of all hardwired interlocks and controls.

4. Functional testing of power actuated valves shall include at least 4 full open-close operations. Testing shall demonstrate the maximum number of operations per hour as recommended by the actuator manufacturer without overheating.

5. Once functional testing of individual pieces of equipment is completed, individual systems functional testing shall commence. Individual system functional testing shall include startup of the complete system of mechanical, electrical, and instrumentation and control equipment as a functional process system. Field inspection prior to startup as specified in the Instrumentation and Control System section, other testing by the Instrumentation and Control System Supplier required to verify readiness for automatic operation of the individual system, shall be completed before commencement of individual system functional testing.

6. Individual system functional testing shall include operation in manual and automatic modes, startup operation, and shutdown in normal and emergency modes. Individual systems shall be tested over their entire operating range and for sufficient time to demonstrate the intended functionality of each piece of equipment and the system. If any part of a system shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made and the functional testing shall be repeated until satisfactory results are obtained.

7. Functional testing of all process and pumping equipment and drive motors, including auxiliary equipment, shall be n accordance with the appropriate and approved test codes, such as those specified by the American Society of Mechanical Engineers, Hydraulic Institute Standards, and IEEE.

8. Qualified personnel from the electrical and mechanical trades responsible for installation of the equipment, shall be available during functional testing involving electrically operated equipment. Where appropriate, a representative of the Instrumentation and Control System Supplier shall also be available.

9. Specific requirements for individual system startup are as follows:

a. *Insert specific requirements*
b.

C. Functional Acceptance Testing.

1. Once the Contractor's functional testing is complete and associated documentation has been submitted and accepted by the Engineer, the Contractor shall conduct functional acceptance testing of each complete process system, to demonstrate individual systems meet the specified requirements. Acceptance testing shall include the successful demonstration of all operating functions and conditions that are specified for the equipment, system, and controls. The manufacturer's representative shall be on Site during acceptance testing when specified in the equipment specifications.

2. The Functional Acceptance Testing shall include the following submissions prior to commencement:

   a. Prerequisite checklist, to be acknowledged by the Engineer prior to initiating the test, that demonstrates that all testing and other Work required to be completed prior to the test is complete.
   b. Listing of Owner's personnel necessary to operate the system and conduct any related monitoring of performance.
   c. A listing of Contractor's personnel designated to supervise and direct the Owner's operators as required herein.
   d. Listing of standby personnel, equipment, and materials that will be available if needed during the test period.
   e. Step-by-step procedures for operation of the facility showing how local and remote control of equipment will be demonstrated.
   f. Description of all data and other information to be reported in support of the completed test. Include any blank data logs that may be used for recording results.
   g. Descriptions of all necessary calculations that must be completed to verify the specified results are being achieved, including formulas.
   h. Blank sign-off form for the test acknowledging the Contractor's, Engineer's, Owner's, and the equipment manufacturer's acceptance of the test.

3. Contractor shall provide Owner and Engineer 14 days notice prior to testing of any individual system.

4. Individual system acceptance testing shall continue for 48 hours without interruption for each system, and all parts shall operate satisfactorily in all respects under a range of conditions to simulate the full operating range of the equipment or system. If there are multiple parallel components or trains, then the testing duration will be 48 hours for each individual train.

5. If any part of a system shows evidence of unsatisfactory or improper operation during the testing period, correction or repairs shall be made and the test repeated until the test is successfully completed. Testing interrupted by power failure will not be required to be repeated, but the test shall be continued upon restoration of power and extended to the specified duration at no additional cost to the Owner.

6. During this testing period the Contractor shall operate all equipment.

1.7 COMMISSIONING.

A. Once startup and testing is complete; documentation of all startup and testing activities shall be submitted for reviewed and accepted by the Engineer.

B. After acceptance, commissioning of the constructed facilities shall be conducted by the Contractor working with the Owner and Engineer.

C. The facility shall be operated in accordance with the operating permit, laws, and regulations.

D. The Contractor shall provide mechanics, electricians, and controls technicians during commissioning as required for troubleshooting and repair.

1.8 OPERATION ACCEPTANCE TESTING.

A. At the completion of the Individual System Acceptance Tests and when the overall process has stabilized sufficiently as determined by the Engineer, operational acceptance testing of the complete facility constructed or modified under the Contract shall be conducted. Operational acceptance testing shall not be conducted concurrently with other individual system acceptance or performance tests.

B. The test shall run at least 14 days with the entire facility operating in the intended manner. The test shall demonstrate to the satisfaction of the Engineer that the facilities are complete and meet all specified requirements and can be continuously operated for their full intended function. During the testing period, the plant shall operate under all control modes, including manual, remote-manual, and automatic. The Owner's staff shall operate the facility.

C. Duty and standby equipment shall be alternated so that all equipment is selected for duty operation for a period of at least 2 days during the test. Unless indicated otherwise, if any item malfunctions or a defect is found during the test, the item shall be repaired and the test either extended a duration to be determined by the Engineer and Owner depending on the severity of the malfunction or defect, or restarted at time zero with no credit given for the operating time before the malfunction or the defect was found. Malfunctions or

defects meeting both of the following conditions may, at the Engineer's discretion, be considered grounds for not requiring restarting the test at time zero:

1. Malfunctions that do not cause an interruption to the operation of the facility because standby equipment can be placed into service.

2. Malfunctions that are corrected within four (4) hours of the time the malfunction is detected. Correction of a malfunction or defect will be considered complete only after the affected equipment is placed back into service and is operating as intended for a continuous period of 24 hours without additional failure.

D. All malfunctions, defects in materials or workmanship, or other flaws, which appear during this test period, shall be immediately corrected by the Contractor ,. If spare parts from the specified spare parts inventory are used to make repairs, they shall be replaced immediately and must be replaced prior to application for final payment.

E. The Contractor shall supply all oil, grease, lubricants, and ancillary equipment required for operational acceptance testing.

F. All plant control system coordination issues shall be resolved and data trending requirements shall be functional during this period.

G. During operational acceptance testing, **[**plant effluent meeting permit requirements as determined by the Owner, will be discharged to the outfall**][**treated water meeting regulatory requirements as determined by the Owner, will be delivered to the distribution system**]**.

1.9 PERFORMANCE TESTING.

A. Performance testing shall be conducted in accordance with requirements specified in the specification sections and contract documents listed below.

1. *Insert name of specification section*

2. The Procurement Documents.

B. The Owner will provide chemicals, water, and power required during performance testing of the new facilities. Contractor shall notify the Engineer 45 days prior to any testing activities to allow the Owner time to order process chemicals and have them delivered to the site for testing. Contractor shall furnish all additional chemicals necessary to complete the test.

1.10 STARTUP SCHEDULE AND STARTUP AND COMMISSIONING PLANS.

A. Plans and schedules shall be developed to facilitate coordinated and efficient startup, testing, and commissioning of the Project equipment and systems.

B. The Contractor shall submit a startup, testing, and commissioning plan and schedule to the Engineer no later than 90 calendar days prior to the commencement of startup and testing. A minimum of 21 days shall be allowed for review by Engineer and Owner. The schedule and plan must be accepted a minimum of 30 days prior to commencement of startup and testing. The schedule and plan shall include sections for startup checks, functional testing, functional acceptance testing, commissioning, **[**and **][**operational acceptance testing**][**, and performance testing**]**.

C. Forms for startup and testing shall include identification of equipment or system, startup/test date, nature of startup/test, startup/test objectives, startup/test prerequisites, startup/test results, instruments employed for the startup/test and signature spaces for the Engineer's witness (where applicable) and the Contractor's startup manager.

D. Startup Schedule.

1. A startup schedule that provides an overall sequence and duration for all startup, testing and commissioning activities, shall be prepared and maintained.

2. This schedule shall serve as a companion to but shall not be a replacement for the startup plan. The startup schedule described in this section shall be integrated into the overall Progress Schedule and shall be prepared as specified for the Progress Schedule in the Construction Progress Schedule section.

3. The Startup Schedule shall be updated weekly to during the startup, testing, and commissioning period.

E. Startup Plan.

1. The Startup Plan shall include the following:

a. Introduction with a narrative description of the overall testing and startup program. The description shall include all contractual or regulatory treatment requirements to be demonstrated.
b. A summary of the objectives and approach for startup checks, functional testing, functional acceptance testing, commissioning, **[**and **][**operational acceptance testing**][**, and Performance Testing**]**.
c. List of the instruments, equipment, and systems that will undergo startup and testing with references to the appropriate PIDs, equipment tags/identification numbers, Specification number and standards for testing procedures.

d. Schedule for startup and field testing for each instrument, piece of equipment (including redundant equipment), and system.
e. Safety and emergency response plan including a list of emergency and non-emergency contacts (email and phone).
f. Organization chart for Contractor's startup and testing personnel with assigned responsibilities for each.
g. Startup and testing record keeping plan.
h. Plan for reuse and disposal of water/wastewater from startup, testing, commissioning including information on any required regulatory permits/approvals.
i. Description of temporary facilities that will be provided.
j. List of chemicals to be provided by the Owner.

2. Within 7 to 14 days of initial submittal of the startup plan, the Contractor shall schedule a workshop with the Owner and Engineer to present the plan. The Contactor shall submit minutes of the workshop, including action items and a schedule for updating the startup plan, to the Engineer within 3 days of the workshop.

3. Individual plans for each phase of startup, testing, and commissioning can be assembled as chapters in the startup plan or submitted as individual documents but should be correlated to ensure there is not disagreement between chapters or separate documents.

F. Startup Checks Plan.

1. The startup checks plan shall be subdivided into plans for each system and major component. Each system/major component plan shall include but not be limited to the following:

a. Identification of information for each component or piece of equipment to be inspected as part of the system. All applicable tag numbers shall be included.
b. Specific activities to be completed on each component, piece of equipment, or system as required to demonstrate proper installation and connection.
c. A tracking checklist of prerequisites for the checks and each step of the checking procedure, including any temporary facilities or utility requirements.
d. Listing of manufacturer's representative(s) to be on site during the check.
e. Sign off forms for the Contractor's startup manager.

G. Functional Testing and Functional Acceptance Testing Plans.

1. The functional testing plan shall include procedures and reporting for functional testing. The functional testing plan shall be subdivided into testing plans for each system. Each system test plan shall include but not be limited to the following:

    a. A narrative description of the purpose and goals of the test for each component, piece of equipment, or system, which should include all activities (including those required by vendors/suppliers) necessary to verify proper equipment and system functionality.
    b. Identification of each component or piece of equipment to be tested as part of the system. All applicable tag numbers shall be included.
    c. Schedule and duration for the tests.
    d. Prerequisites for each test, including any temporary facilities or utility requirements.
    e. Pass/fail criteria for the test.
    f. A checklist for tracking testing progress which includes prerequisites for the test and each step of the testing procedure. The check list shall include specified performance criteria that are to be met.
    g. A description of test apparatus required to conduct the test.
    h. Identification of all temporary facilities and chemicals require during startup.
    i. Listing of manufacturer's representative(s) to be on site during the test.
    j. Certificates of proper installation, as applicable to the test.
    k. Step-by-step detailed procedure of the test. The level of detail shall be sufficient for a witness to be able to follow the steps during the test and be confident that the test is being performed as planned. All steps required to proceed through the test in an orderly manner are considered significant and each of these steps shall be included in the procedure.
    l. Copies of the data recording forms that will be used during the test.
    m. Calculation methodologies to be used to evaluate the data and/or test criteria for the test.
    n. Sample computations or analyses for the test with results in the same format as the final report. This item is intended to demonstrate how data collected will be used to generate final results. A sample shall be included for each type of computation required for the test and analysis of results.
    o. Blank sign-off forms for the test acknowledging the startup manager's, Engineer's, Owner's, and equipment manufacturer's acceptance of the test where applicable.

2. The functional testing plan shall identify constraints for individual systems start up, and shall include the following:

    a. Insert constraints
    b.

1.11 REPORTS AND RECORDS.

A. Records of all startup and testing shall be compiled by the Contractor and submitted to the Engineer.

B. Prior to being submitted to the Engineer, the startup manager shall certify that the results recorded and the tested systems comply with the Contract requirements.

C. Records shall include all documentation assembled for each piece of equipment or system involved in the startup and testing, including all certifications, forms, and check lists completed during the startup and test, and sign-off forms.

D. Records of all startup and testing shall be compiled as separate documents for each system tested, and shall be submitted within 48 hours of completion of the startup and testing for each system.

E. Testing samples that require analysis periods greater than 48 hours shall be clearly defined in the startup plan but shall not preclude delivery of the balance of the records within the 48 hour timeframe.

F. The Contractor shall provide formal reporting and documentation of failures, malfunctions or defects, and repairs made during the startup and/or testing activities.

G. A “System Problem Report” form is included at the end of this section, and shall be used by the Contractor to document problems that arise during these tests and their resolution. Records submitted shall include “System Problem Report” forms completed during testing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SYSTEM PROBLEM REPORT

Project Name: *Insert Project Name*			
Test Name:			
Test Number:			
Problem Type: Hardware Software Documentation Unknown Other			
SYMPTOMS:	Time:	Date:	By:
Description:			
Can problem be reproduced at will? Y / N			
DIAGNOSIS:	Time:	Date:	By:
Description:			
CORRECTION:	Time:	Date:	By:
Description:			
FINAL SIGN OFF	Time:	Date:	By:

SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the demolition and relocation of existing structures, piping, equipment, and sitework and the salvage of existing materials and equipment as indicated on the Drawings.

1.2 GENERAL

A. Contractor shall be responsible for all work under this section. Contractor shall provide 28 days written notice prior to beginning demolition activities.

B. All structures and facilities of the existing wastewater treatment plant which are not to be removed must remain in continuous operation during the work.

C. Demolition and salvage work shall create minimum interference with Owner's operations and minimum inconvenience to Owner. Contractor shall provide protection and safety of all roadways, sidewalks, and all accessible areas during demolition activities.

D. Blasting will not be permitted.

1.3 SUBMITTALS

A. Demolition Plan.

1. Contractor shall submit a detailed demolition plan indicating the major demolition activities, planned dates, Owner coordination requirements, permit requirements (if any), and any special planning considerations that require coordination with third-parties.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Removal of equipment or facilities shall include removal of all accessories, piping, wiring, supports, associated electrical starters and devices, baseplates and frames, and all other appurtenances, unless otherwise directed. Existing materials and equipment removed, and not

indicated to be reused as a part of the Work, shall become Contractor's property unless otherwise specified, and shall be removed from the Site and properly disposed of or recycled in accordance with state laws.

B. Contractor shall conduct demolition activities in a manner that prevents damage to existing facilities which are indicated to remain and shall provide all necessary protection for existing facilities. Any remaining facilities damaged during demolition shall be repaired by Contractor to a condition equal to or better than the original condition.

C. When demolition is complete, all debris shall be removed from the Site and the Site graded to the lines and grades indicated on the Drawings.

D. Structure Demolition

1. The following structures at the wastewater treatment facility shall be demolished, and the debris shall be.removed from the jobsite.

   a. Foundation of surface aerators
   b. Foundation of the power pole

E. Piping and Equipment Demolition

1. The following piping and equipment shall be removed and shall become the property of Contractor. All such items shall be promptly removed from the jobsite.

   a. Surface Aeraotors (Total quantity 12 nos.)
   b. Shed (total quantity 2 no.)

F. 12” Water Line (length 330ft)Sitework Demolition

1. Sitework demolition shall include the following:

   a. Removal of gravel pavement, within the limits indicated on the Drawings.
   b. Removal of trees and shrubs indicated on the Drawings within the limits of disturbance to be removed and as required to complete the work.
   c. Removal of the manhole tops, risers, and rings and covers for the manholes indicated on the Drawings.
   d. Relocation of all existing power poles.
   .
   e. Removal of existing 12” water piping within the limits indicated on the Drawings. Sewer pipework as indicated on the drawing to be abandoned shall be plugged with concreteAbandon of existing sewer line of length as indicated on the Drawings.

End of Section

SECTION 03 01 26.66 - CONCRETE CRACK REPAIR

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the repair of concrete and shotcrete cracks and joints.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

C. General Crack Repair

1. General crack repair is applicable only to new construction, and shall include the following:

a. Sealing of all cracks and crack networks that are wider than 10 mils (0.01 inch) as measured at the exposed surface.
b. All necessary repairs to structures that have failed a tightness test, including sealing of construction joints.

2. All costs for general crack repair shall be included in the Contract Price. General crack repair work is expected to be necessary due to cracks that commonly develop during concrete construction.

D. Engineer-Directed Crack Repair

1. Engineer-directed crack repair is applicable only to new construction, and shall only be performed when instructed by Engineer. The work shall include, but is not limited to, the following:

a. Sealing of construction joints that are not otherwise required to be sealed as the result of a failure of a leakage test.
b. Sealing of cracks and crack networks with a width of 10 mils (0.01 inch) or less as measured at the exposed surface.

2. Contractor shall include 150 linear feet of Engineer-directed crack repair in the Contract Price. The Engineer-directed crack repair may be either epoxy resin or foam resin, as determined by Engineer.

E. Pre-Defined Crack Repair

1. Pre-defined crack repair is applicable only to existing structures, and the extent of this type of repair is indicated on the Drawings.

2. Prior to beginning the repair work Contractor shall field verify and provide clear bright colored marking to the cracks to be repaired. Crack repair work shall not begin until marking is complete and has been approved by Engineer.

1.2 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Experience record of the applicator.

A letter from each product manufacturer indicating their approval of the following.

Selection of repair material.

Qualifications of the individuals performing the work.

Surface preparation procedures.

Application procedures.

Curing procedures.

1.3 QUALITY ASSURANCE

A. Manufacturer's Field Services

1. The material manufacturer shall provide engineering field services to review the Work and the material application prior to any preparation; to approve the applicator, the material used, and the procedure to be used; to observe surface preparation; to approve surface preparation; and to observe application. The field representative of the material manufacturer shall submit, in writing through Contractor, approvals of proposed material, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

B. Applicator

1. The applicator shall submit through Contractor a satisfactory experience record including references from previous application of the specified materials to structures of similar design and complexity.

C. Pre-Construction Meeting

1. At least 30 days prior to concrete crack repairs, Contractor shall conduct a meeting to review the detailed requirements for rehabilitation work. Site conditions, surface preparation, proposed equipment, procedures, material mixing, placing procedures, and curing methods shall be discussed and approved by Engineer and by the manufacturer's field representative. Contractor shall require the attendance of all involved parties, including but not limited to Contractor's superintendent, repair contractor, manufacturer's field representative and proposed equipment supplier representative. Minutes of the meeting shall be recorded, typed and printed by Contractor and distributed to all parties within 5 days after the meeting.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless otherwise specified or authorized, repairs shall conform to the requirements specified herein. Types of repairs not specified herein shall be as specified in other sections, as indicated on the Drawings, or, in the absence of any definite requirement, as recommended by the manufacturer's representative and subject to acceptance by Engineer. The following types of repairs shall be performed as required.

B. Epoxy Resin

1. Unless indicated otherwise on the drawings, epoxy resin shall be used to seal construction joints and cracks. Epoxy resin shall be pressure-injected for vertical and overhead applications. Epoxy resin may be applied by gravity feed in lieu of pressure injections for cracks in floors, using a very low-viscosity material.

C. Foam Resin

1. Foam resin shall be used to seal expansion joints. Otherwise, foam resin shall only be used to seal crack and joints when indicated on the drawings or when permitted by Engineer in lieu of epoxy resin. Foam resin shall be pressure-injected.

2.2 ACCEPTABLE PRODUCTS

A. Repair products/materials shall be as specified herein. Equivalent products of other manufacturers regularly producing high quality concrete crack repair products/materials, providing engineering field services, and meeting the specified quality assurance requirements may be furnished subject to review and acceptance by Engineer.

2.3 MATERIALS

A. Materials shall be approved by the manufacturer for the type of application, including temperature and moisture conditions encountered. Products shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600 for structures that are part of the treatment process for producing potable water.

Epoxy Resin	ASTM C881, Type I or Type IV, moisture tolerant or moisture insensitive.
Crack Sealant	As recommended by the manufacturer of the epoxy resin product.
Foam Resin	Hydrophilic polyurethane foam; Prime Resins “Prime-Flex 900 XLV”, DeNeef "Sealfoam PURe", Euclid “Dural Aqua-Fil”, or Avanti “AV 330 Safeguard”.
Foam Resin Accelerator	As recommended by foam resin manufacturer.
Water	Clean and free from deleterious substances.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to the placement of the repair materials, the crack to be repaired shall be inspected by the material manufacturer to assure that preparation and conditions are correct for the type of repair and the product/material being used as specified herein.

3.2 PREPARATION

A. All cracks and surfaces around the cracks shall be free of objectionable substances and shall conform to the requirements of the material manufacturer. Concrete and shotcrete to be repaired shall be cleaned by methods acceptable to the material manufacturer so that the cracks are free of dirt, oil, grease, laitance, and other foreign matter. All loose and deteriorated existing concrete and shotcrete shall be removed down to sound materials. All concrete and shotcrete surfaces shall be checked for delamination to ensure that all surfaces are sound. All edges shall be square cut to avoid feather edges.

B. Any other preparation recommended by the material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

C. Concrete and shotcrete surfaces in the area of a crack to be repaired shall be cleaned by wire brushing, blasting, or other acceptable methods.

D. Wall surfaces shall be sandblasted clean to expose crack networks and construction joints. If there is active water seepage in the repair area, the seepage shall be stopped as recommended by the injection material manufacturer and as acceptable to Engineer. Injection ports shall be installed, when recommended by the injection material manufacturer.

E. Injected Epoxy Resin

1. Preparation for injected epoxy resin shall include sealing the surface at the crack, on both sides when possible, with crack sealant as recommended by the material manufacturer and as acceptable to Engineer for the pressure injection work. Injection ports for epoxy resin shall penetrate through the crack sealant into the cracks at spacings recommended by the material manufacturer.

F. Injected Foam Resin

1. Preparation for injected foam resin shall include drilling offset injection holes at an angle that will intersect the crack, joint, or crack network at approximately one-half the thickness of the concrete or shotcrete up to a thickness of 36 inches . Spacing of injection ports shall be determined as recommended by the injection material manufacturer and as acceptable to Engineer. When the injection material manufacturer certifies, in writing, that spacing of injection ports and installation procedures are acceptable, the injection ports may be installed directly into the crack, subject to review by Engineer.

3.3 APPLICATION

A. Concrete and shotcrete repair work shall be performed in accordance with the following requirements.

B. Crack Sealant

1. Crack sealant shall be trowel-applied to a minimum dried thickness of 1/8 inch , or thicker if directed by manufacturer’s literature. The concrete surface where the sealant is applied shall be smooth, uniform, and free from irregularities. Crack sealant shall be removed after the injection of resin is completed, except for portions of wall faces that will be at least 12 inches below the finished grade.

C. Pressure-Injected Resin

1. The injected areas shall be prepared as specified and as recommended by the manufacturer.

2. After the joints and cracks are prepared and before the injection of the resin, the joints shall be flushed with water. The water flush shall be terminated when the turbidity of the expelled water is equal to that of the flush water. Unless otherwise acceptable to resin manufacturer and Engineer, cracks shall be dry prior to injecting resin.

3. The pumping equipment used for the pressure injection of resin shall have pressure metering. Written procedures for use and quality control of the injection equipment shall

be furnished to Engineer for review and acceptance. The pump shall be electric. The material and process used for the pressure injection of the resin shall have been in use a minimum of 5 years.

4. The joints and crack networks shall have a minimum of 90 percent penetration of resin into the joint or crack network. Core samples may be taken at Engineer's discretion.

5. Epoxy Resin

   a. Epoxy resin shall be injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Epoxy resin shall be injected until the resin appears at the next injection port.

6. Foam Resin

   a. Foam resin shall be premixed and injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Foam resin shall be injected into the structure until the resin appears at the next injection port.
   b. Surfaces of cracks and joints may need to be sealed with crack sealant.

D. Gravity Fed Resin

1. A bead of the epoxy resin shall be placed over the entire surface of the crack. Enough resin shall be applied so that there is a visible heaping above the floor surface.

2. The applicator shall periodically inspect the resin to verify that it has penetrated the crack and flattened against the floor surface.

3. After the resin has flattened, another bean shall be applied, and the process repeated until the crack cannot receive additional resin.

E. Cold Weather

1. When ambient temperatures below 40° F are expected during the curing period, the repair materials shall be maintained at a temperature of at least 50° F for 14 days or 75° F for 7 days after placement. Sudden cooling of the repair materials shall not be permitted.

3.4 PROTECTION

A. Post-placement curing and protection shall be as specified herein and in accordance with the manufacturer's recommendations.

3.5 CLEANING

A. Work areas shall be cleaned each day in accordance with the Project Requirements section. Upon completion of the final cleanup, Contractor shall restore all areas affected by the repair procedures to their original condition, leaving no trace of material piles or other wasted materials.

End of Section

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SECTION 03 08 13 - TIGHTNESS TESTING OF STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers hydrostatic tightness testing of concrete structures.

B. Tightness testing, cleaning, and disinfection of steel storage reservoirs and tanks, elevated steel tanks, and piping systems are covered in other sections.

1.2 GENERAL

A. Unless otherwise specified, testing shall be completed after the entire concrete structure has been constructed, cured, and has attained its design strength, but prior to placement of backfill, cleaning and disinfection, and prior to the installation of equipment in the structure.

B. All testing work shall be performed by Contractor in the presence of Engineer.

C. Testing Schedule and Procedure

1. A testing schedule and procedure shall be submitted to Engineer for review and acceptance not less than 30 days prior to commencement of testing. The schedule shall indicate the proposed time and sequence of testing for each structure. The procedure shall indicate the limits of the area to be tested, define the method of isolation, the position and use of valves during testing, the location of temporary bulkheads, the process for introducing water and air into the structure, the method of measuring water and air losses, any correction methods required due to evaporation and precipitation, the method and location for disposal of testing water, and any other activities relevant to the testing.

2. Contractor shall notify Engineer at least five days in advance of the time that testing of any individual structure will begin.

3. Contractor shall submit tightness testing of each structure to Engineer for approval.

D. Water

1. Water for testing will be furnished as stipulated in the temporary facilities section. Water shall be conserved through collection and reuse in subsequent tests. Following completion of testing work, the water shall be disposed of in a manner acceptable to Engineer and, unless otherwise permitted by Engineer, shall not be allowed to enter other parts of the system.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All necessary connections between the structure to be tested and the water source or other test medium, together with pumping equipment, any necessary metering devices, pressure or vacuum gauges, and all other equipment, materials, and facilities required to perform the specified tests and dispose of the test medium after completion of testing, shall be provided by Contractor. Contractor shall provide all required temporary flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices that may be necessary to perform the testing. All temporary devices shall be removed upon satisfactory completion of testing.

2.2 STRUCTURES TO BE TESTED

A. The structures to be tested are indicated in the Tightness Testing of Structures schedule.

2.3 ALLOWABLE WATER LOSS

A. The maximum allowable water loss and the test duration shall be as specified in the Tightness Testing of Structures schedule.

B. Adjustments for evaporation and precipitation shall be required when indicated in the schedule. A partially filled plastic pan or tub having dimensions proportionately similar to those of the basin shall be placed in the basin and monitored to account for evaporation or rainfall.

C. Each leak which is discovered during the correction period shall be located and repaired at the expense of Contractor.

PART 3 - EXECUTION

3.1 HYDROSTATIC TEST PROCEDURES

A. The hydrostatic test shall consist of both a visual inspection and a water loss measurement. Both tests shall be completed to the satisfaction of Engineer. The procedure and sequence of testing shall be subject to review and acceptance by Engineer.

B. Unless otherwise specified, tightness testing shall be performed after all pipe sleeves have been installed but before backfilling or the interior waterproofing material or coating has been applied or exterior dampproofing material has been applied.

C. Paint that has been applied to piping, valves, or other items shall be permitted to dry in accordance with the paint manufacturer’s instructions prior to introducing test water into the tank.

D. Exposed concrete surfaces of the structure, including the floor, shall be cleaned of all foreign material and debris prior to the test. Standing water in or outside the structure that would interfere with observation of the exposed concrete surfaces shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired prior to filling the tank with water.

E. Adjacent structures having common walls shall be tested individually at different times to permit examination of the dividing walls for leaks.

F. Pipe connections or openings to structures, if not provided with drip tight valves, shall be temporarily plugged during testing. Where slide gates, sluice gates or similar devices are located, Contractor shall provide bulkheads or the means to make them drip tight, and measure any leakage.

G. Unless otherwise specified, each structure to be tested shall be filled with potable water at a uniform rate not to exceed a depth of 4 feet per hour to the level specified in the Tightness Testing of Structures schedule. The water shall be allowed to stand for at least three days prior to tightness testing in order to stabilize the absorption rate of the concrete and the water temperature. During this period, sufficient water shall be added to maintain the water level to the elevation specified.

H. Visual Inspection

1. All structures to be tested shall be free from visible leaks. Damp spots on exterior wall surfaces shall be considered visible leaks if moisture can be picked up on a dry hand. Damp spots on tops of wall footings will be permitted unless the water can be observed to be flowing. Repairs shall be made to visible leaks regardless of the water loss test results. All visible leaks which have not spontaneously plugged or demonstrated a definite decrease in the rate of leakage over a maximum period of 28 days shall be located and repaired by and at the expense of Contractor in accordance with the Concrete Crack Repair section. The structure shall be retested to confirm that the repairs are satisfactory.

I. Water Loss Measurement

1. Measurements of water level and loss will be taken by Engineer each day over the test period. If the measured drop in water level, adjusted for evaporation and precipitation when applicable, exceeds the allowable amount specified in the Tightness Testing of Structure schedule and does not show a definite decreasing trend during the following 7 day period, the structure shall be drained, repaired in accordance with the Concrete Crack Repair section, cleaned, refilled, and retested to the satisfaction of Engineer.

2. Testing shall be considered void and the basin shall be retested in the event of excessive evaporation or precipitation that results in an empty or overflowing pan.

J. Disposal of Test Water

1. Contractor shall confirm that Owner intends to dispose of the test water. If the water is to be disposed of, Contractor shall verify there is no residual chlorine or other undesirable product in the test water to be discharged. If necessary a neutralizing chemical treatment

shall be provided to condition the water prior to disposal. Contractor shall be responsible to determine a suitable location and method for disposing of the used test water. Water discharged to overland disposal or to a sewer system shall be discharged at flow rates and locations acceptable to the local governing agencies and in compliance with applicable rules and regulations.

End of Section

SCHEDULE 03 08 13-S01 - TIGHTNESS TESTING OF STRUCTURES

	Hydrostatic Testing				Pneumatic Testing	
	Water Surface Elevation	Allowable Water Surface Drop	Test Duration	Consider Evaporation and Precipitation	Allowable Pressure Loss	Test Duration
Structure	ft	Inches	days	(Y/N)	inches WC	minutes
Chlorine Contact Basin	627.71	0.231	5	Y		
Junction Structure	630.00	0.27	5	Y		

End of Section

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SECTION 03 11 00 - CONCRETE FORMING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers formwork for cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. All forms shall be accurately and properly placed so cast-in-place concrete may be placed as indicated on the Drawings and as specified. The forms shall produce a smooth concrete finish free from offsets or irregularities.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

PART 2 - PRODUCTS

2.1 MATERIALS.

Forms

Prefabricated	Simplex "Industrial Steel Frame Forms," Symons "Steel Ply," or Universal "Uni-form."
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir, face adjacent to concrete Grade B or better.
Fiberboard	ANSI/AHA A135.4, Class 1, tempered, water-resistant, concrete form hardboard.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.

Chamfer Strips	Clear white pine, surface against concrete planed.
Form Coating	Nonstaining and nontoxic after 30 days. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site. **Coatings shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600 for structures that are part of the treatment process for producing potable water.**

2.2 FORMS

A. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the Drawings. Forms shall conform to ACI 347R and the following additional requirements.

1. Stay-in-place metal formwork will not be permitted.

2. Form-facing materials shall be selected in accordance with ACI 347.3R, based upon the applicable formed concrete surface category. Formed concrete surface categories vary by structure and application, and shall be as indicated in the Concrete Finishing section. Other types of forming materials, such as steel or unlined wood, may be used where plywood or lined forms are not required, and may be used as backing for form linings. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas, within the tolerances specified herein.

3. All vertical concrete surfaces above footings shall be formed.

4. Flat segmented forms not more than 24 inches wide may be used for forming curved surfaces 25 feet in diameter or larger.

B. Design

1. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that permissible working stresses are not exceeded.

2. Beams and slabs supported by concrete columns shall be formed so that the column forms may be removed without disturbing the supports for the beams or slabs.

3. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be placed at the proper location on the forms so that the concrete surface can be finished with a screed or template to the specified elevation, slope, or contour. At

horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet above the joint.

4. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

C. Form Ties

1. Form ties shall have removable end and permanently embedded body, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portion shall be at least 1 inch back from the concrete face. Form ties for walls with waterstops at joints shall be provided with water stop washers located on the permanently embedded portions of the ties at the approximate center of the wall. The ties shall be smooth at the location of the water stop washer; continuously threaded systems will not be acceptable. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. Through-wall tapered removable ties will not be acceptable. The type of form ties used shall be acceptable to Engineer.

2. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

D. Edges and Corners

1. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners, unless specifically indicated otherwise on the Drawings. Unless otherwise noted, bevels shall be 3/4 inch wide.

PART 3 - EXECUTION

3.1 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

B. Before concrete is placed, forms shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

3.2 TOLERANCES

A. Tolerances for cast-in-place concrete work shall be as indicated in ACI 347.3R, based upon the relevant formed concrete surface category.

B. Formed concrete surfaces that are to have a face-mounted flat steel or FRP member attached, including but not limited to items such as weir plates or shelf angles, shall have more stringent flatness requirements. The surface profile shall permit the installation of the flat member without grinding the concrete surface (except for removal of fins), deforming the flat member, or requiring usage of backer rods or shims.

3.3 FORM COATING

A. All concrete forms shall have form release agent applied to them before placement of concrete.

3.4 FORM REMOVAL

A. Forms shall not be removed from structures until the concrete in the structures has sufficient strength to support the weight of the structure and any superimposed load, including loads from construction operations. Contractor shall be responsible for limiting any applied loadings. There shall be no evidence of damage to concrete and no excessive deflection or distortion of members due either to the removal of forms or to loss of support.

B. Supporting formwork (soffit material only) for horizontal members shall not be removed until the concrete has attained at least 75 percent of the specified 28 day compressive strength as determined by cylinders made and cured in the field. Shoring systems for horizontal members shall not be removed until the concrete has attained the full specified 28 day compressive strength, but may be temporarily removed for the purpose of removing the soffit material as permitted above. Shoring shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.

C. When forms are removed before the specified curing is completed, measures shall be taken to immediately continue curing and to provide adequate thermal protection for the concrete.

End of Section

SECTION 03 15 19 - CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers concrete accessories including construction, contraction and expansion joints for cast-in-place concrete.

B. Dovetail anchor slots shall be as specified in the Masonry section.

C. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. All accessories shall be accurately placed and all joints shall be accurately and properly constructed so cast-in-place concrete can be placed as specified and as indicated on the Drawings.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Drawings or figures indicating the location of all construction joints, expansion joints, and contraction joints.

Drawings or figures indicating the location of all waterstops including prefabricated or specialty pieces at turns, intersections, and changes of waterstop types.

PART 2 - PRODUCTS

2.1 MATERIALS

Stainless Steel Waterstops	ASTM A240, Type 31 stainless steel, fabricated in 6-inch wide plates, 14 gage minimum thickness.

PVC Waterstops	Material shall meet the requirements of CRD-C-572, shall be white (no pigment), ribbed, 3/8 inch min thick, size as indicated on the drawings. Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12 inches on center entire length.
6 inches wide, at construction joints	Sika Greenstreak ”679”, JP Specialties “PVC637”, or Vinylex ”R638.”
6 inches wide, at control joints	“O” bulb closed center section; Sika Greenstreak “732”, JP Spcialties “PVC638”, or Vinylex “RB638H.”
TPE-R Waterstops	Thermoplastic elastomeric rubber, meeting the CRD-C-572 requirements for tensile strength, elongation, and low temperature brittleness. Black, ribbed, center bulb, size as indicated on the drawings. For ozone resistance – no cracking at 450 pphm per ASTM D1171.
6 inches wide	3/16 inches min thick; minimum 0.5 lbs/ft . J.P. Specialties “Earth Shield – Part No. 636” or Westec “Style 619.”
Expansion joint materials	
Filler	Preformed sponge rubber, ASTM D1752, Type I.
Filler adhesive	As recommended by manufacturer.
Sealant	As specified in the Joint Sealants section.
Polyethylene film	NBS Product Standard PS17 or ASTM D4397, 6 mils or thicker.
Vapor retarder and seam tape	Polyolefin membrane, 15 mil min, ASTM E1745, Class A, with maximum water vapor permeance of 0.02 perms. Stego Industries “Stego Wrap 15 Mil,” Raven Industries “Vaporblock 15,” Reef Industries “Griffolyn 15 Mil Green,” W.R. Meadows “Perminator 15,” Insulation Solutions “Viper VaporCheck II.” Manufacturer recommended seam tape and pipe boots.
Bearing pads (damp or humid environment)	Neoprene, natural rubber, or PVC.
Neoprene	Minimum ultimate tensile strength of 1500 psi, minimum elongation of 500% (ASTM D412), and a maximum compressive set of 50% (ASTM D395 Method A), with hardness of 30 to 60 durometers (ASTM D2240, Type A Durometer). Neoprene shall contain only virgin, crystallization-resistant polychloroprene as the raw polymer, and physical properties shall be in accordance with ASTM D2000, Line Call-Out M2BC4105A14B14.

Natural rubber	Rubber shall contain only virgin natural polyisoprene as the raw polymer, and physical properties shall be in accordance with ASTM D2000, Line Call-Out M4AA41413.
PVC	PVC shall meet CRD-C-572.
Epoxy bonding agent	As specified in Concrete Placing section.
Grease for dowels at expansion joints	The lubricant shall be applied to the steel dowel as indicated on the drawings to reduce bond with the surrounding concrete. Grease shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600 for structures that are part of the treatment process for producing potable water. At other locations, use all-purpose grease intended for greased dowels placed in expansion joints.

PART 3 - EXECUTION

3.1 CONSTRUCTION JOINTS

A. Construction joints shall be made at locations indicated on the Drawings or where specified. Construction joints shall not be made at other locations without the concurrence of Engineer.

B. Location

1. Construction joints shall be located as follows:

a. Bottom Slabs. Slabs with a transverse reinforcement pattern shall be divided into approximately square sections not to exceed 60 feet in their longest dimension. Slabs with a radial and circumferential reinforcement patter shall be divided into circular segments not to exceed 60 feet diameter, or into pie-shaped segments not to exceed 60 feet in the longest circumferential distance.

b. Columns. Provide joints at the underside of beams, girders, haunches, drop panels, and column capitals, and at floor levels. All haunches, drop panels, and column capitals shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Column bases will not be required to be monolithic with the floor beneath.

c. Walls. Provide joints at the underside of beams, girders, haunches, drop panels, and at floor levels. All haunches and drop panels shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Walls shall be divided into sections not to exceed 60 feet in length. Joints shall be located within 30 feet of corners for liquid-containing structures and within 40 feet of corners for non-liquid containing structures. Walls supporting beams shall have pockets blocked out so that the full beam cross section penetrates the full thickness of the wall. Where waterstops are required in the joint, the wall pocket shall be

widened and deepened to prevent interference between the waterstop and the beam reinforcement.

d. Beams, Girders and Suspended Slabs. Provide joints within the middle third of the span, and as close as practicable to the 1/3 point of the span. If a beam intersects a girder, the joint in the girder shall be offset by at least twice the width of the beam. Integral beam and slab systems shall be monolithic and shall have identical joint locations within spans. Members shall be divided into pour sections not to exceed 60 feet in length.

2. Construction joints in all concrete elements shall be perpendicular to the planes of their surfaces.

3. Construction joints shall be located to maintain at least 9 inches clear from any embedded item such as anchor bolts, castings, steel shapes, conduits, pipe sleeves, etc.

C. Watertight Joints

1. Construction joints in the following locations shall be watertight and shall be provided with continuous waterstops.

a. For liquid-containing structures, provide in slabs below the liquid surface elevation, and in all perimeter walls to their full height.
b. For liquid-containing structures, provide in divider walls where it is possible for one side or "cell" to be out of service while the other remains liquid-containing.
c. For filters and clear water reservoirs, provide in all walls, base slabs, and top slabs.
d. Provide in other locations specifically indicated on the Drawings.

3.2 EXPANSION AND CONTRACTION JOINTS

A. Expansion joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler. Accessible edges of each expansion and contraction joint shall be sealed as specified in the caulking section.

3.3 WATERSTOPS

A. Placement

1. Each waterstop shall be continuous throughout the length of the joint in which it is installed. Waterstops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted. Waterstops shall be securely positioned using tie wire and hog rings. Waterstop embedment shall be equal on both sides of the joint.

2. Expandable waterstops shall be located as nearly as possible to the center of the joint and shall not be installed when air temperature falls outside the manufacturer's recommended range.

B. Storage and Handling

1. Expansion joint filler and elastomeric (PVC or TPE-R) waterstops shall be stored in a cool place protected from direct sunlight.

2. Metal waterstops shall be handled, transported, delivered, and stored in a manner which will prevent bends, dents, or corrosion.

C. Splices

1. Junctions between adjacent sections of metal waterstops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.

2. Junctions between adjacent sections of elastomeric (PVC or TPE-R) waterstops shall be spliced in strict conformity with the recommendations of the manufacturer. Directional changes and intersections shall be factory fabricated by the waterstop manufacturer prior to delivery to the Site. Field splices will be acceptable only in straight sections.

3. Expandable waterstops shall be contact lapped a minimum distance of 8 inches . Voids shall be filled with sealant.

4. Where an expandable waterstop is used in combination with metal or PVC water stops, the expandable water stop shall be placed in contact and shall overlap a minimum distance of 12 inches . Voids shall be filled with sealant.

3.4 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

3.5 EMBEDMENTS

A. Anchor bolts, castings, steel shapes, conduits, sleeves, masonry anchors, and other objects that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.

B. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be placed on the concrete side of the form or template. A second nut shall be placed on the other side of the form or template, and the two nuts shall be so adjusted that the bolt will be held rigidly in proper position.

3.6 DUCT BANK JOINTS

A. Hardened surfaces that are to receive additional concrete shall be prepared by removing all loose particles, scum, and laitance so that the aggregate is exposed. The hardened surface shall then be thoroughly wetted and a thin coating of neat cement mortar shall be spread over the

entire surface just before the fresh concrete is placed. The fresh concrete shall be puddled and spaded to eliminate any honeycomb or lack of mortar near the joint.

3.7 PLACEMENT AGAINST SUBGRADE

A. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high-pressure water spray.

B. Polyethylene Film

1. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film. Joints in the film shall be lapped at least 6 inches and taped.

C. Vapor Retarder

1. Vapor retarder shall be installed at the locations indicated on the Drawings. Installation shall be in accordance with ASTM E1643 and the manufacturer's recommendations. Joints in the retarder shall be sealed with waterproof sealing tape. Care shall be exercised to avoid tearing or puncturing the retarder. Any damage shall be promptly repaired, and the retarder shall be inspected for damage immediately before the concrete is placed.

3.8 BEARING PADS

A. Wherever a concrete beam is supported by a concrete bracket, a bearing pad shall be placed in the joint between the beam and the bracket. Bearing pads for sliding joints shall be attached to the hardened surface to prevent uplift during subsequent placement of concrete. Nailing of pads shall not be permitted.

End of Section

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers reinforcement for cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Bar lists and drawings for the fabrication and placing of reinforcement, with sufficient plans, elevations, and sections to adequately detail and label all reinforcement. Bar drawings shall also include a reference to the structure where the reinforcement is to be installed and the relevant contract drawings showing the reinforcement.

C. Reinforcement fabrication drawings shall not be submitted until Engineer has reviewed and accepted submittals for the locations of construction joints and concrete placement sequences.

PART 2 - PRODUCTS

2.1 MATERIALS.

Bars	ASTM A615, Grade 60, deformed.
Bars, Weldable	ASTM A706 or A615, Grade 60, deformed, with maximum carbon equivalent of 0.55%.
Shear Bars	ASTM A615, Grade 60, smooth.
Bar Supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected. Precast concrete bricks shall not be

	used without approval of Engineer.
Mechanical Connectors	Splicing system meeting Type 2 tensile requirements of ACI 318. Products shall have a current evaluation report verifying testing per ICC-ES AC 133.
Threaded Type	Dayton Superior “DBDI Splice System,” nVent “LENTON Mechanical Splicing Systems”, or Barsplice Products “Grip-Twist” system.
Locking Type	Dayton Superior “Bar-Lock Coupler System”, nVent “LENTON Connect System”, or Barsplice Products “Zap Screwlock Type 2 Mechanical Connector” system.

2.2 REINFORCEMENT

A. Reinforcement shall be accurately formed and shall be free from loose rust, scale, concrete splatter, and contaminants which reduce bond. Unless otherwise indicated on the Drawings or specified herein, the details of fabrication shall conform to ACI SP-66 and ACI 318. Reinforcement shall not be bent in the field without approval of Engineer.

B. Splices

1. Splices shall conform to the details indicated on the Drawings. Splices at locations other than those indicated on the Drawings shall be submitted to Engineer for review and concurrence.

2. The reinforcement splice locations shall be coordinated with the construction joint locations and concrete placement sequence.

C. Mechanical Connectors

1. Mechanical connectors shall be used only as indicated on the Drawings. Connections in adjacent bars shall be spaced at least 30 inches apart.

D. Welding

1. Except where indicated on the Drawings, welding or tack welding of reinforcement is not permitted. Preheating and welding shall conform to AWS D1.4. Reinforcement which has been welded improperly or without Engineer’s concurrence shall be removed and replaced.

PART 3 - EXECUTION

3.1 STORAGE AND HANDLING

A. Reinforcing steel shall be carefully handled and shall be stored on supports which prevent the steel from touching the ground.

3.2 PLACEMENT

A. Reinforcement shall be accurately positioned on supports, spacers, hangers, or other reinforcement, and shall be secured in place with wire ties or suitable clips. Tolerances shall be as stipulated in ACI 117 and ACI 318 unless otherwise indicated.

B. Reinforcement at the bottom of concrete slabs and mats shall not be supported from contact with subgrade by the use of metal supports or bent reinforcement.

C. Where reinforcement in beams is placed in two or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

D. Reinforcement for elevated beams or slabs shall not be installed until the concrete for the supporting wall or column system has been placed and compacted.

E. Before concrete is placed, reinforcement shall be rigidly secured in proper position. All surfaces encrusted with dried concrete from previous placements shall be cleaned and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow before concrete is placed.

3.3 PLACING CONCRETE

A. Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns.

3.4 DUCT BANKS

A. All reinforcement and other magnetic materials installed in duct banks shall be installed parallel to the individual ducts, unless they enclose all the ducts of the duct bank.

End of Section

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SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers procurement of all cast-in-place concrete, including concrete materials, limiting requirements, mixture design, and performance requirements, and delivery to the Site through discharge at the end of the delivery truck chute.

B. Pervious concrete, lightweight aggregate concrete, or lightweight cellular concrete shall not be used for any concrete covered by this section.

C. Work beyond the end of the delivery truck chute is covered in the Concrete Forming, Concrete Joints and Accessories, Concrete Reinforcing, Concrete Placing, Concrete Finishing, and Concrete Curing sections.

D. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. All cast-in-place concrete shall conform to the limiting requirements of this specification including Table 1.

B. Concrete Classifications

1. Concrete classifications shall be defined and used as indicated for the following classes:

C. Concrete Classifications

Class	Class Description
A.	Structural Concrete
A1.	Concrete for Liquid-Containing Structures. Concrete for liquid-containing environmental structures, liquid-containing tanks, interior suspended slabs in high humidity areas, headwalls, chemical storage or containment areas, below grade structures exposed to groundwater under normal conditions, and all other concrete not otherwise indicated.
A2.	Small Aggregate Concrete; Congested Areas. Structural small aggregate concrete shall be used in all areas (including liquid-containing structures) where the clear distance between reinforcement, conduit, or embedded items is less than the largest dimension of coarse aggregate particles in the structural concrete.

Class Class Description

A3. Concrete for Non-Liquid-Containing Structures. Concrete for footings, foundations, manholes, catch basins, pan-formed joists, and all other structural concrete other than for liquid-containing structures.

A4. Mortar Puddle. Placed in a lift 2 inches or more deep at the bottom of forms for walls and columns immediately before structural concrete is placed.

B. Exterior Flatwork Concrete. Concrete for exterior slabs on grade, plant pavement, sidewalks, curbs and gutters, and small equipment pads.

D. Miscellaneous Concrete

D1. Ductbanks, Pipe Blocking, Concrete Fill, and Pipe Encasement Concrete. Concrete used in ductbanks, pipe blocking, concrete fill and pipe encasements.

D6. Composite Topping Concrete. Concrete placed as a cap over a properly prepared concrete subsurface, placed as a topping over precast hollowcore or double tee sections, or used for repair, leveling, raising a finished surface elevation.

D7. Lean Concrete. Used as a fill material for over-excavations or for mud slabs below foundations. Controlled Low-Strength Material (CLSM) used as an easily removable fill material is covered in the Excavation and Fill for Structures section.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The required submittal data for each Class of concrete shall be as indicated in Tables 2A, 2B, and 2C. The sequencing of the submittal data shall be as follows.

C. Preliminary Review of Materials

1. Reports covering the source and quality of concrete materials proposed for the work shall be submitted to Engineer for review within 30 days after the preconstruction conference.

2. The submittal shall include Submittal Cover Page #1, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

3. Manufacturer's information shall be submitted for all concrete ingredients, in the form of technical data sheets, certificates of compliance, test data, or reports.

D. Proposed Mixture Proportions

1. Data indicating the proposed material quantities in each Class of concrete shall be submitted to Engineer for review within 30 days after the preconstruction conference.

2. The submittal shall include Submittal Cover Page #2, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

E. Mixture Test Results

1. Concrete mixture test results shall be submitted to Engineer for review and acceptance.

2. The submittal shall include Submittal Cover Page #3, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

3. Compressive strength shall be qualified by field test record data only for the Classes of concrete indicated as such in Table 2C. Compressive strength shall be qualified by laboratory testing for other Classes.

4. Laboratory trial mixture testing shall not begin until materials and proposed mixture proportions have been reviewed and are acceptable to Engineer.

1.4 STORAGE AND HANDLING

A. Cement, slag cement and fly ash shall be stored in suitable moistureproof enclosures. Cement, slag cement and fly ash which have become caked or lumpy shall not be used.

B. Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Unless otherwise specified, each concrete mixture shall be designed and controlled, within the following limits, to provide a dense, durable concrete suitable for the expected service conditions.

B. Concrete materials shall be selected and concrete shall be proportioned, batched, mixed, and delivered in a manner that will minimize shrinkage and cracking as specified herein, and in accordance with Chapters 3 and 8 of ACI 224R. Concrete temperatures shall be controlled before and until delivery at the end of the delivery truck chute to minimize cracking. Any rise in concrete temperature caused by environmental conditions that will be conducive to excessive shrinkage shall be controlled.

C. For each class of concrete, each concrete mixture shall be designed and concrete shall be controlled within the limits in the specification and in Table 1.

D. Cementitious Material Content Limits

1. The cementitious material content shall be suitable for meeting the performance requirements of this specification.

2. Contractor may substitute fly ash for cement within the percentage ranges indicated in Table 1, on the basis of 1.0 lbs of fly ash added for each lb of cement reduction.

3. Contractor may substitute slag cement for cement within the percentage ranges indicted in Table 1 on the basis of 1.0 lbs of slag cement added for each lb of cement reduction.

E. Maximum Water-Cementitious Material Ratio

1. The maximum water-cementitious material ratio shall be on a cement mass basis, or, if fly ash or slag cement is used, the combined mass of cement plus fly ash or slag cement shall be used to determine the water-cementitious materials ratio. Limiting maximum water-cementitious material ratios are indicated in Table 1.

F. Aggregates

1. Aggregates shall comply with ASTM C33 except as specified herein. Recycled aggregates, or aggregates created from crushed concrete, will not be acceptable. Fine aggregate shall be clean natural sand. Artificial or manufactured sand shall not be used unless acceptable to Engineer. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material, meeting Class 4S requirements, except that clay and shale particles shall not exceed values indicated in Table 1.

2. Gradation of coarse aggregate shall conform to maximum nominal size grading requirements of ASTM C33. When a combination of two or more sizes is used, the combined gradation shall meet ASTM C33 requirements.

3. Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete trial mixtures. Reports of individual aggregates shall include sieve sizes 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, and No. 50 in accordance with ASTM E11.

4. Specified sand equivalent for fine aggregate shall be not less than indicated in Table 1 for an average of 3 samples tested in accordance with ASTM D2419.

5. To comply with the specified concrete shrinkage test requirements, the clay and shale content of the aggregates may need to be reduced by washing the aggregate.

G. Ratio of Fine to Total Aggregates

1. The ratio of fine to total aggregates, based on solid volumes (not weights), shall be as follows:

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
3/8 inch	0.45	0.60
1/2 inch	0.40	0.55

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
3/4 inch	0.35	0.50
1 inch	0.30	0.46
1-1/2 inch	0.25	0.40

H. Slump

1. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough consolidation. Prior to the addition of admixtures, slump shall be at least 2 inches and shall not exceed the maximum slump as indicated in Table 1.

2. When superplasticizer is dispensed at the ready-mix plant, the concrete mixture design shall be based on a maximum slump as indicated in Table 1. When superplasticizer is dispensed at the Site, the slump of the concrete delivered shall not exceed the maximum slump as indicated in Table 1 before superplasticizer is added.

I. Initial Set

1. The initial set, as determined by ASTM C403, shall be attained 5-1/2 hours ±1 hour after the water and cementitious materials are added to the aggregates for each concrete mixture. The quantity of retarding admixture shall be adjusted to compensate for variations in temperature and job conditions.

J. Total Air Content

1. The total volumetric air content of concrete after placement shall be as indicated in Table 1, and within ±1.5 percent. Air-entraining admixture may be omitted from concrete for interior floor surfaces which are to be steel trowel finished.

K. Admixtures

1. Only approved or specified admixtures shall be used.

2. Unless otherwise acceptable to Engineer, all admixtures shall be from one manufacturer and shall be compatible. Admixtures that are compatible with other admixtures and concrete materials shall not have an adverse effect on the required properties of the concrete nor the specified limiting requirements. The admixture content, batching method, and time of introduction to the mixture shall comply with these specifications and with the manufacturer's recommendations for minimum shrinkage. The admixture manufacturer shall provide qualified field services as necessary, at no additional cost to Owner.

3. Admixtures used in the concrete shall be reviewed and accepted by Engineer prior to conducting the laboratory trial mixture testing and the shrinkage testing. No calcium chloride nor admixture containing chloride from sources other than residual impurities in admixture ingredients will be permitted.

4. Combination of admixtures which cause premature or local dehydration or post-compaction settlement of the concrete surface shall not be used. If any such undesirable characteristics are observed, the use of the mixture shall be discontinued and an alternate mixture design used.

5. All liquid-containing (Class A1) concrete, and small aggregate (Class A2) concrete that is placed in liquid-containing structures, shall include a high-range water reducing admixture (superplasticizer). Water-reducing admixtures are not required for Classes D1 and D7, but may be included at Contractor's option. For all other non-liquid-containing concrete, a water-reducing admixture shall be used.

6. Superplasticizer may be dispensed into the concrete at the plant or on the Site and shall be mixed in accordance with the admixture manufacturer's recommendations. Each superplasticizer dose, when dispensed at the Site, shall be easily verifiable and recorded on the delivery ticket. The superplasticizer for each load shall be accurately proportioned into a separate container prior to dispensing the admixture into the concrete. When truck-mounted dispensers are used, the system shall not be flushed or cleaned with water until after the entire load of concrete has been discharged. When permitted by Engineer, redosing of concrete with superplasticizer shall be done only once. Redosing procedures shall be as recommended by the admixture manufacturer.

7. A shrinkage reducing admixture may be added to Class A1 concrete. It shall replace an equal volume of mixing water or as otherwise recommended by the admixture manufacturer. The quantity of air entrainment admixture shall be adjusted as required by the admixture manufacturer to keep mixture air content within specified limits.

L. Strength

1. In addition to the other limiting requirements to achieve durability and minimize shrinkage, the minimum acceptable compressive strengths of concrete tested at the end of the delivery truck chute, as determined by ASTM C39, shall be as indicated in Table 1.

2. Adequate test cylinders taken at the point of placement shall also be made to verify that Contractor's concreting procedures comply with applicable industry standard procedures.

M. Pumped Concrete

1. Coarse aggregate size for pumped concrete mixtures shall be limited to a nominal maximum of 1-1/2 inch .

N. Water-Soluble Chloride

1. Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 days shall not exceed the limits expressed as a percentage of mass of cementitious materials as indicated in Table 1.

2. Test results shall be reported as the percentage of water-soluble chloride ions in the concrete and as a percentage of chloride ion relative to the mass of cementitious materials in the concrete.

3. Testing of the concrete components for water-soluble chloride ions may be done at the discretion of Contractor. Copies of the reports on such tests shall be furnished to Engineer.

4. The hardened concrete and each gradation of aggregate used in the concrete shall be tested each time a chloride ion test is conducted on a concrete mixture.

O. Laboratory Shrinkage Limits

1. Based on the modified ASTM C157 test procedures as specified herein, the shrinkage limits of concrete shall be the average drying shrinkage of each set of three test specimens cast in the laboratory from a trial mixture as measured at the 21 days drying age, and shall not exceed the values in Table 1.

P. NSF/ANSI 61 and NSF/ANSI 600 Compliance

1. All liquid-containing (Class A1) concrete, small aggregate (Class A2) concrete, and concrete fill (Class D1) that is used in structures that are part of the treatment process for producing potable water shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600.

2. Compliance shall be as defined below.

   a. Structures that contain at least 350,000 gallons of water under normal operating conditions shall have all admixtures compliant with NSF/ANSI 61 and NSF/ANSI 600.
   b. Structures with a diluted surface area (DSA) to volume ratio of 0.8 in^2/L or less shall have all admixtures compliant with NSF/ANSI 61 and NSF/ANSI 600.
   c. Structures not meeting the total volume or the DSA-to-volume ratios indicated above shall be NSF/ANSI 61 and NSF/ANSI 600 compliant based on one of the two following options:
      1) All constituent materials shall be certified as NSF/ANSI 61 and NSF/ANSI 600 compliant, including mix water, aggregates, admixtures, and all cementitious materials.
      2) Tests shall be performed on samples of concrete using the actual ingredients and proportions proposed for the project. Testing of concrete samples shall follow NSF/ANSI 61 and NSF/ANSI 600 protocol for cast-in-place cylinder tests and evaluation.
      3) The following structure shall be certified based on one of these two methods.
         a) Chlorine Contact Basin
         b) Junction Structure

Q. Cold Weather Concrete

1. Except as modified herein, cold weather concrete shall comply with ACI 306.1. The temperature of concrete at the point of delivery at the end of the delivery truck chute shall be not less than that indicated in ACI 306.1 for corresponding outdoor temperature (in shade) at the time of placement.

2. When delivered, heated concrete shall be not warmer than 80°F .

R. Hot Weather Concrete

1. Except as modified herein, hot weather concrete shall comply with ACI 305.1. At air temperatures of 90° F or above, concrete shall be kept as cool as possible before and during delivery. The temperature of the concrete at the time of delivery at the end of the delivery truck chute shall not exceed the values indicated in Table 1.

2.2 MATERIALS

Cement	ASTM C150 Type I, II, or I/II, or ASTM C595 Type IL. ASTM C595 cements that incorporate ASTM C1157 cements will not be acceptable.
Fly Ash	ASTM C618, except that loss on ignition shall not exceed 4 percent. Class F or Class C are acceptable, but Class C shall also be qualified for moderate sulfate resistance as described in ASTM C618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C1012.
Slag Cement	ASTM C989, Grade 100 or Grade 120.
Aggregates, Fine and Coarse	As specified in Limiting Requirements paragraph.
Water	Potable. Water from concrete production operations shall not be used.
Admixtures	
Water Reducing/Normal Set	ASTM C494, Type A, except as otherwise specified herein.
Water Reducing/Retarding	ASTM C494, Type D, except as otherwise specified herein.
Air-Entraining	ASTM C260.
High Range Water Reducing/Normal Set	ASTM C494, Type F, extended slump life type, except as otherwise specified herein.
High Range Water Reducing/Retarding	ASTM C494, Type G, extended slump life type, except as otherwise specified herein.
Shrinkage Reducing Admixture	GCP Applied Technologies (Grace) “Eclipse 4500,” Euclid “Eucon SRA,” or Master Builders Solutions “MasterLife SRA 035.” These admixtures shall not be used when NSF/ANSI 61 and NSF/ANSI 600 certification is required.

Mineral Coloring	ASTM C979; nonfading mineral coloring unaffected by sunlight or free alkali; Davis Colors "Mix-Ready," L.M. Scofield "Chromix," or Euclid "Super Concentrated Mortar Color."

2.3 MIXTURE DESIGN AND TESTING

A. As stipulated in the Quality Control section, all reports and tests required for preliminary review of materials and for laboratory trial mixtures shall be made by an independent testing laboratory at the expense of Contractor. Mixtures shall be adjusted in the field as necessary, within the limits specified, to meet the requirements of these specifications. If the type or source of any concrete ingredient is changed during the contract, including a change from ASTM C150 to ASTM C595 cement, concrete work shall pause until the new materials and the new mixture design are tested in accordance with the specified requirements.

B. Preliminary Review of Materials

1. The tests and reports required shall be as indicated in Table 2A. Review of these reports shall be for general acceptability only, and continued compliance with all contract provisions shall be required.

2. Aggregate reports shall be no more than 90 days old at time of submittal.

3. Alkali-aggregate reactivity potential shall be determined by one of the following procedures. Field performance history as described in ASTM C1778 will not be an acceptable method for qualifying aggregates.

   a. Test fine and coarse aggregates in accordance with ASTM C1260. Aggregates which are classified as innocuous may be used without further testing.
   b. Test fine and coarse aggregates in accordance with ASTM C1567, using a single aggregate with all cementitious materials selected for the Project. The fine and coarse aggregates shall not be combined and used in a single test. This test may only be used for mixtures that contain slag cement or fly ash, and those products shall not have an alkali content greater than 4.0 percent sodium oxide equivalent. Combinations of cementitious materials and aggregate which do not indicate a potential for alkali reactivity may be used without further testing. Mixture combinations which indicate a potential for alkali reactivity shall have the ingredients and/or proportions modified and then the test shall be repeated.
   c. Test fine and coarse aggregates in accordance with ASTM C1293. Concrete mixtures containing only cement (without pozzolan or slag cement) shall be tested accordingly and have a measured expansion of 0.04 percent or less at one year duration. Concrete mixtures containing pozzolan or slag cement shall be tested with those ingredients in proportions matching that of the proposed mixture, and shall have a measured expansion of 0.04 percent or less at two years duration.

4. At the discretion of Engineer, testing in addition to that indicated herein or in ASTM C1778 may be performed on potentially reactive aggregates. Nonreactive aggregates shall be

imported if, in the opinion of Engineer, local aggregates exhibit unacceptable potential reactivity.

C. Proposed Mixture Proportions

1. Proposed proportions for each Class of concrete shall meet the limiting requirements indicated herein.

D. Mixture Testing

1. Test results on each Class of concrete shall be submitted for review and shall be acceptable to Engineer before concrete work is started. The reports shall include the information indicated in Table 2C.

2. Field Test Record Data

a. If indicated as acceptable in Table 2C, concrete mixtures may be qualified based upon field test record performance data in lieu of laboratory trial mixtures. Field test data records shall be from the production facility being used on the current Project and shall have been performed in the past 24 months. Field test records shall represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days.

3. Laboratory Trial Mixture Testing

a. Trial mixtures shall be tested in the laboratory for each size and combined gradation of aggregates and for each consistency as indicated and intended for use on the work and as specified.
b. Concrete ingredients shall be measured and mixed in the laboratory. Concrete test specimens shall be made, cured, and stored in accordance with ASTM C192 and tested in accordance with ASTM C39.
c. Concrete proportions shall be established based on laboratory trial mixtures that meet the following requirements:
1) The combination of materials shall be as proposed for use in the work.
2) Mixtures shall conform with the limiting requirements specified herein.
3) The required average compressive strength, f'_{cr}, of the trial mixture shall exceed the specified minimum acceptable compressive strength, f'_{cr}, as required in Table 1.
4) Trial mixtures of the proportions and consistencies specified for the work shall be prepared. When a three point curve is required by Table 2C, the three concrete trial mixtures shall reflect the cement content proposed for the Project and for the indicated concrete class at three water-cementitious material ratio contents at or lower than indicated in Table 1. The compressive strength of the cylinders made from the three trial mixtures shall produce a range of compressive strengths exceeding or encompassing the f'_{cr} required for the work.
5) For each proposed concrete mixture that is required to be tested as indicated in Table 2C, compressive strength test cylinders shall be made for each testing

age. Each change in the water-cementitious materials ratio shall be considered a new concrete mixture. Each mixture shall be tested at the ages of 7 days and 28 days.

6) When a three point curve is required in Table 2C, the results of the cylinder tests for each water-cementitious materials ratio at each age shall be plotted as a curve showing the relationship between compressive strength (along y-axis) and the water-cementitious materials ratio (along x-axis). The water-cementitious materials ratio and the associated average compressive strength for the Project concrete mixture shall be selected from the 28 day curve. The maximum water-cementitious materials ratio specified in the limiting requirements shall still apply even if the curve indicates that the concrete strength would be adequate at a higher ratio. The cement content and mixture proportions to be used shall be such that the selected water-cementitious materials ratio will not be exceeded at specified maximum slump. These concrete mixture proportions shall be submitted for review in accordance with the Submittals Procedures section.

7) When a shrinkage reducing admixture is proposed, trial mixtures shall be prepared with and without the shrinkage reducing admixture.

4. Testing Procedures

a. Concrete mixture testing procedures shall be as specifier herein, and reports for these tests shall be prepared specifically for this Project.

b. Aggregates shall be sampled and tested in accordance with ASTM C33. The bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

c. Slump shall be determined in accordance with ASTM C143. Unit weight (mass) shall be determined in accordance with ASTM C138. Total air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138. Concrete temperature shall be determined in accordance with ASTM C1064.

d. Initial set tests shall be made at ambient temperatures of 70° F and 90° F to determine compliance with the specified time for initial set. The test at 70° F shall be made using concrete containing the specified normal set/water-reducing admixture and, when required, air-entraining admixture. The test at 90° F shall be made using concrete containing the specified retarding/water-reducing admixture and, when required, air-entraining admixture. Initial set shall be determined in accordance with ASTM C403.

e. Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch . The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular class of concrete shall be performed using the same sized cylinders for the duration of the work.

f. Water-soluble chloride ion shall be determined in accordance with ASTM C1218.

g. A drying shrinkage test shall be conducted on the trial mixture with the maximum water-cementitious materials ratio used to qualify each proposed concrete mixture design using the concrete materials, including admixtures, that are proposed for the Project. Three test specimens shall be prepared for each test. Drying shrinkage specimens shall be 4 inch by 4 inch by 11 inch prisms with an effective gauge length of 10 inches , fabricated, cured, dried, and measured in accordance with ASTM C157 except with the following modifications:

1) Specimens shall be removed from the molds at an age of 23 hours ±1 hour after batching, shall be placed immediately in water at 73°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in lime-saturated water as specified in ASTM C157. Measurement to determine expansion expressed as a percentage of original length shall be taken at age 7 days. The length at 7 days shall be the base length for drying shrinkage calculations ("zero" days drying age). Specimens then shall be stored immediately in a humidity controlled room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as a percentage of the base length shall be reported separately for 7, 14, and 21 days ±4 hours of drying from "zero" days after 7 days of moist curing for a total of 28 days from the date of casting.
2) Drying shrinkage deformation for each specimen shall be computed as the difference between the base length (at "zero" days drying age) and the length after drying at each test age. Results of the shrinkage test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results for that specimen shall be disregarded.
3) The average drying shrinkage of each set of 4 inch by 4 inch by 11 inch test specimens made in the laboratory from a trial mixture shall not exceed the values required in Table 1.

h. NSF/ANSI 61 and NSF/ANSI 600 compliance shall be demonstrated in accordance with mechanisms outlined in those standards. Any associated laboratory testing of concrete constituents or cylinders shall be coordinated with the laboratory activities associated with the other limiting requirements of this section. For cylinder tests, an ANSI accredited certification report shall be submitted for each applicable concrete mixture, along with a compliance evaluation for each concrete structure requiring compliance.

PART 3 - EXECUTION

3.1 BATCHING, MIXING, AND DELIVERY

A. Concrete shall be furnished by a ready-mixed concrete manufacturer (plant) and trucks which are certified by the National Ready Mixed Concrete Association's (NRMCA) Plant and Truck Certification Program, and shall conform to ASTM C94 except as indicated otherwise in this specification. The time from start of concrete mixing to completion of discharge from the truck shall not exceed 1-1/2 hours.

B. Delivery Tickets

1. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be handed to Engineer by the truck operator at the time of delivery. Tickets shall indicate the name and location of Contractor, the project name, the mixture identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cementitious materials were added, and the numerical sequence of the delivery.

C. Mixing Water

1. Mixing water shall not be added in transit. Any amount of water withheld from the truck mixer shall be clearly indicated on the delivery ticket. Water added at the site shall not exceed the amount withheld, and shall not be added without oversight by Owner's on site inspector.

D. Consistency

1. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall flow uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

3.2 CONTRACTOR'S ONGOING MATERIAL TESTING

A. The following tests and test reports are required during the progress of the work and shall be made at the expense of Contractor.

B. Test reports shall be provided at increments of 5000 cubic yards of concrete placed, but not less than once per six months of concrete production time, unless otherwise acceptable to Engineer.

C. Contractor shall submit the following data to Engineer for review to confirm that the concrete mixture ingredients remain in compliance with the requirements of this section.

1. Aggregate gradation reports, for both fine and coarse aggregates, to verify continued compliance with ASTM C33. Testing procedures shall match those described in Part 2 of this specification section.

2. Sand equivalent reports, to verify continued compliance with this specification section. Testing procedure and acceptability criteria shall match that described in Part 2 of this specification section.

3. All cementitious material certificates, per the ASTM standards described in Part 2 of this specification section.

3.3 OWNER'S FIELD CONTROL TESTING

A. Field control tests, including slump, air content, and making compression test cylinders, shall be performed by Engineer or Owner's testing laboratory personnel, at the expense of Owner. Contractor shall provide access to all facilities and the services of one or more employees as necessary to assist with the field control testing.

B. The frequency specified herein for each field control test is approximate and subject to change as determined by Engineer.

C. Field control testing will not be performed for Classes D1, D4, or D7, unless Owner specifically requests and schedules such testing. Other special inspection requirements applicable for these classes of concrete will still be performed.

D. Engineer may require field testing prior to the addition of superplasticizer at the Site to determine compliance with the specifications. Field testing after the addition of superplasticizer shall be conducted as specified and as needed to determine that the concrete is in compliance with the specifications. Air content tests shall be conducted whenever field tests are conducted.

E. Slump

1. A slump test shall be made for each 100 cubic yards of concrete. Slump shall be determined in accordance with ASTM C143.

F. Air Content

1. An air content test shall be made on concrete from one of the first three batches mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138.

G. Unit Weight

1. A unit weight test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Unit weight shall be determined in accordance with ASTM C138.

H. Concrete Temperature

1. A concrete temperature test shall be made on concrete from the first batch of concrete mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. During hot or cold weather concreting operations, temperature shall be checked not less than once per hour. Concrete temperature shall be determined in accordance with ASTM C1064.

I. Water-Soluble Chloride Ion

1. Water-soluble chloride ion testing shall be performed once for each 1,000 cubic yards of concrete in accordance with ASTM C1218

J. Compression Tests

1. One set (six individual cylinders) of concrete compression test cylinders shall be made not less than once each day concrete is placed, not less than once for each 100 cubic yards of each class of concrete, and not less than once for each 5000 square feet of surface area for slabs or walls. Half of the cylinders of each set shall be tested at an age of 7 days and the remaining cylinders shall be tested at an age of 28 days.

2. Test cylinders shall be made, cured (standard curing method), stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39.

3. Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch . The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular mixture class shall be performed using the same sized cylinders for the duration of the work and shall match the cylinder size used for the trial mixtures.

4. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the number of the delivery truck or batch, the air content, the slump, the unit weight, and the concrete temperature.

K. Shrinkage Tests

1. Concrete shrinkage tests shall be performed once for each 1,000 cubic yards of concrete with controlled shrinkage that is placed and shall be made on concrete from a batch of concrete from which concrete compression test cylinders are made. Shrinkage testing shall be conducted as specified for the preliminary trial mixtures.

2. The average drying shrinkage of each set of test specimens cast in the field from concrete delivered to the Site and sampled at the end of the delivery truck chute, as measured at the 21 days drying age, shall not exceed the values indicated in Table 1.

L. Test Reports

1. Five copies of each test report shall be prepared and distributed by the testing laboratory to the Owner, Resident Project Representative (two copies), Engineer, and Contractor, in accordance with the Quality Control section.

3.4 EVALUATION AND ACCEPTANCE OF CONCRETE

A. Concrete will be evaluated for compliance with all requirements of the specifications. Concrete strength will be only one of the criteria used for evaluation and acceptance of the concrete. The results of all tests performed on the concrete and other data and information concerning the

procedures for handling, placing, and curing concrete will be used to evaluate the concrete for compliance with the specified requirements.

B. Compression tests will be evaluated in accordance with ACI 318 and as specified herein. A strength test shall be the average of the compressive strengths of two 6 inch diameter cylinders or three 4 inch diameter cylinders, made from the same concrete sample tested at 28 days.

C. Compression Test Evaluation

1. Compressive strength test results will be evaluated for compliance with the specified strength requirements. The strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'_c, and no individual strength test result falls below the specified compressive strength by more than 500 psi .

D. Inspection of Concrete Supplier

1. Both scheduled and unscheduled visits by inspectors on days of concrete pours shall be accommodated. Inspectors shall be allowed access to delivery tickets and mixture proportions.

TABLE 1 – LIMITING REQUIREMENTS														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1.	Compressive Strength, minimum; psi														
	Field, 7 days;	3375	3375	3375	3000	3000	3000	3000	2250	3000	**	3000	3000	3000	1500
	Field, 28 days; f'_c	4500	4500	4000	4000	4000	4000	4000	3000	4000	**	3000	4000	4000	2000
	Laboratory, 28 days; f'_{cr}	5700	5700	5700	5200	5200	5200	5200	3200	5200	**	4200	5200	5200	2000
2.	Maximum water-cementitious material ratio	0.42	0.42	0.45	0.45	0.45	0.48	0.45	0.65	0.45	**	0.45	0.45 0.40[a]	0.42	0.75
3.	Maximum nominal coarse aggregate size, inches	1	1/2	1-1/2	Sand	1-1/2	1-1/2	1	1	1-1/2	**	3/8	1/2	3/4	1-1/2
4.	Maximum slump, inches														
	Slump before super-plasticizer added	3	3	4	6	6	4	3	5	6	**	4	4	4	6
	Slump after adding superplasticizer	8	8	8	8	8	8	8	8	9	**	8	8	8	10
5.	Total air content, percent, (± 1.5 %)	6	7.5	6	6	6	6	6	---	---	**	---	6	6	---
6.	Fly ash replacement, percent range	15-25	15-25	15-25	15-25	15-30	15-25	15-25	15-30	15-25	**	15-30	15-35	15-25	15-30
7.	Slag cement replacement, percent range	25-50	25-50	25-50	0	25-50	25-30	0	25-50	0	**	0	0	25-50	25-50
8	Testing limits														
	Sand equivalent, min. percent	75	75	75	75	75	75	75	---	75	**	75	75	75	---
	Chloride ion, max. percent	0.08	0.08	0.15	0.08	0.30	0.15	0.10	0.30	0.30	**	---	0.15	0.15	---
	Shrinkage, max. percent; based 4 x 4 x 11 inch specimen														
	Laboratory	0.036	0.036	0.048	---	---	0.048	0.048	---	0.048	**	---	---	0.048	---

TABLE 1 – LIMITING REQUIREMENTS														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Field	0.048	0.048	0.064	---	---	0.064	0.064	---	0.064	**	---	---	0.064	---
	Coarse Aggregate: Clay and shale combined particles shall not exceed, max. percent	1	1	1	1	1	3	2	10	1	**	3	1	2	3
9	Concrete temperature at time of delivery and placement, max. ° F	85	85	90	85	90	95	85	95	95	**	90	85	85	95

NOTES:

* "D2" (Underwater concrete) - Limit aggregate to 3/4" for reinforced concrete, up to 1-1/2" for unreinforced concrete.

** "D3" (Mass Concrete) limiting requirements shall be as indicated in the Mass Concrete section.

[a] "D5" Wash water trough top edge water-cementitious ratio, 100 percent sand passing No. 8 sieve.

TABLE 2A – SUBMITTAL REQUIREMENTS (PRELIMINARY REVIEW OF MATERIALS)														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1	Aggregate reports														
	Fine aggregate														
	Source and type	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Gradation	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Deleterious materials	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Fineness modulus	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	X	X	X	X	X	X	**	---	X	X	X
	Sand equivalent	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Coarse aggregate														
	Source and type	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Gradation	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Deleterious materials	X	X	X	---	X	X	X	X	X	**	X	X	X	---
	Abrasion loss	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Soundness test	X	X	X	---	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	---	X	X	X	X	X	**	---	X	X	X
	Combined aggregate gradation	X	X	X	---	X	X	X	X	---	**	X	---	---	---
2	Cement, mill report	X	X	X	X	X	X	X	X	X	**	X	X	X	X
3	Cementitious material, type, data sheet, and test report (fly ash, slag cement)	X	X	X	X	X	X	X	X	X	**	X	X	X	X
4	Admixtures														
	Data sheets and certifications	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Manufacturer’s approval letter	X	X	X	X	X	X	X	X	X	**	X	X	X	X
5	NSF/ANSI 61 and NSF/ANSI 600 compliance, for each proposed concrete constituent, where applicable	X	X	---	---	---	---	---	X	---	**	---	---	---	---

TABLE 2B – SUBMITTAL REQUIREMENTS (PROPOSED MIXTURE PROPORTIONS)														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
6	Mixture proportions, reports	X	X	X	X	X	X	X	X	X	**	X	X	X	X

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
7	Type of testing														
	Field test records acceptable	---	---	---	---	---	---	---	X	---	**	X	X	X	X
	Trial mixtures required	X	X	X	X	X	X	X	---	X	**	---	---	---	---
8	Test Reports Required														
	Confirmation of materials tested														
	Cement brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Fly ash brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Specific gravity of each aggregate	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Ratio of fine to total aggregates	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Water content	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Water-cementitious materials ratio	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Slump	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Unit weight	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Air content	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Temperature	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Time of initial set at 70° F and 90° F.	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Three point curves	X	X	X	---	---	---	X	---	X	**	---	---	---	---

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Compressive strength at 7 and 28 days	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Water-soluble chloride ion	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Drying shrinkage	X	X	X	---	---	X	X	---	X	**	---	---	X	---
	NSF/ANSI 61 and NSF/ANSI 600 compliance evaluations where applicable	X	X	---	---	---	---	---	X	---	**	---	---	---	---

NOTES:

** "D3" (Mass Concrete) submittal requirements shall be as indicated in the Mass Concrete section.

Appendix – Submittal Cover Pages

Submittal Cover Page #1 – Preliminary Review of Materials	
Subject	Insert Submittal Page Number(s)
FINE AGGREGATE REPORTS	
Source and Type	
Gradation	
Deleterious Materials	
Fineness Modulus	
Alkali-Aggregate Reactivity	
Sand Equivalent	
COARSE AGGREGATE REPORTS	
Source and Type	
Gradation	
Deleterious Materials	
Abrasion Loss	
Soundness Test	
Alkali-Aggregate Reactivity	
Combined Aggregate Gradation	
CEMENTITIOUS MATERIAL REPORTS	
Cement Mill Report	
Fly Ash Report	
Slag Report	
ADMIXTURES	
Data Sheets and Certifications	
Manufacturer's Approval Letter	

Submittal Cover Page #2 – Proposed Mixture Proportions																
	Insert Submittal Page Number(s)															
Subject	A1	A2	A3	A4	A5	A6	A7	B	C	D1	D2	D3	D4	D5	D6	D7
Water-Cementitious Material Ratio																---
Ratio of Fine-to-Total Aggregates				---						---	---		---			---

Submittal Cover Page #3 – Mixture Test Results														
	Insert Submittal Page Number(s)													
Subject	A1	A2	A3	A4	A5	B	C	D1	D2	D3	D4	D5	D6	D7
Slump (pre HRWR)								---						---
Slump (after HRWR)								---						---
Unit Weight				---				---			---			---
Air Content				---				---			---			---
Temperature								---			---	---	---	---
Time of Set								---			---	---	---	---
Lab Compressive Strength (7 days)								---			---	---	---	---
Lab Compressive Strength (28 days)								---			---	---	---	---
Three point curves				---	---	---		---			---	---	---	---
Field Compressive Strength (28 days)	---	---	---	---	---	---	---		---	---				
Water-soluble chloride											---			---
Shrinkage				---	---			---			---	---		---
ANSI/NSF 61 and 600			---	---	---	---	---		---		---	---	---	---

End of Section

SECTION 03 30 13 - CONCRETE PLACING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers placing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly placed as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Concrete placing sequence, when required for any specific structures.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Concrete shall be handled and placed in a manner that will minimize shrinkage and cracking as specified herein. Concrete temperatures shall be controlled both before and after placement to minimize cracking.

2.2 MATERIALS

Epoxy Bonding Agent	ASTM C881, Type V, moisture insensitive, 100 percent solids; Dayton Superior "Sure Bond J58," Euclid "Dural 452 MV," Prime Resins "Prime Bond 3900 High Mod LPL," or SpecChem "SpecPoxy 2000."

PART 3 - EXECUTION

3.1 RECEIVING

A. Contractor shall check each delivery ticket to verify the concrete class delivered to the jobsite is in compliance with the concrete requested and is suitable for Contractor's handling, placing, finishing, and curing procedures. Engineer will collect the delivery tickets from the truck operator.

3.2 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer. All concrete within the predetermined limits shall be placed in one continuous operation.

B. Before concrete is placed, forms, reinforcement, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

C. Contractor shall inform Engineer at least 24 hours in advance of any concrete placement.

D. Bonding to Hardened Concrete

1. The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. Before placement of plastic concrete, the hardened surface shall be cleaned of all laitance and foreign substances (including curing compound), washed with clean water, wetted thoroughly, and the surface made free of standing water. Surface profile of the hardened concrete after surface preparation shall be as required for good bond.

2. Epoxy bonding agent shall only be required where specifically indicated on the project drawings or specifications. Fresh concrete shall be applied when bonding agent is still tacky. Bonding agent material that has exceeded the manufacturer’s recommended pot life shall be removed.

3. Coarse aggregate shall be omitted from the first batch or batches of concrete placed on hardened concrete in wall or column forms. The mortar puddle, Class A4 concrete, shall cover the hardened concrete by at least 2 inches at every point.

E. Conveying Concrete

1. Methods of conveying concrete to the point of final deposit shall prevent segregation or loss of ingredients. After placement in the forms, concrete shall not be moved laterally more than 5 feet . Concrete's free fall should not exceed 4 feet .

F. Pumping Concrete

1. The slump of concrete, with or without a superplasticizer, which is discharged into the pump may exceed the specified maximum slump value by the amount of slump loss in the pumping system, up to a maximum of 1 inch . The slump loss shall be determined by tests made at each end of the pumping system. If tests indicate a slump loss greater than 1 inch in the pumping system, Contractor shall modify the pumping system as required to reduce the slump loss to 1 inch or less.

G. Placing Concrete

1. For proper compaction, concrete shall be placed in approximately horizontal layers not to exceed 24 inches . Each layer of concrete shall be plastic when covered with the following layer, and the rate of vertical rise of the concrete in the forms shall not be less than 24 inches per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

2. The height of any portion of a wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet . Concrete in walls or columns shall have achieved initial set before concrete is placed in the structural systems to be supported by such walls or columns.

3. Concrete shall be thoroughly settled in wall forms before top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

H. Compaction

1. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Mechanical vibrators shall maintain at least 14,000 cycles per minute when immersed in the concrete. The number and type of vibrators shall be acceptable to Engineer. The use of “jitterbug” tampers to compact concrete flatwork will not be permitted.

I. Cold Weather Concreting

1. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

2. Massive embedded items identified on the drawings shall be above 32° F [0° C] when the concrete is placed.

3. When placed, heated concrete shall not be warmer than 80° F .

J. Hot Weather Concreting

1. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

2. At air temperatures of 90° F or above, concrete shall be kept as cool as practicable during placement. The temperature of the concrete when placed in the work shall not exceed the values indicated in the Cast-in-Place Concrete section.

3. Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 lb per square foot per hour , as determined using the nomograph in Appendix A of ACI 305.1.

K. Placement Sequence

1. The following structures shall be constructed using a placement sequence:

a. Chlorine Contact Basin
b. Chemical Building
c. Junction Structure

2. For these structures, concrete shall be placed as follows:

a. Bottom Slab. Bottom slabs shall be divided into sections of the sizes and shapes indicated on the drawings or in the Concrete Joints and Accessories section. A section near the center of each structure shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Placement shall be scheduled so that two adjacent sides of each section are free, except at closures.
b. Walls. Walls shall be divided into sections of the sizes and shapes indicated on the drawings or in the Concrete Joints and Accessories section. A section near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Placement shall be scheduled so that one end of each section is free, except at corner closures.
c. Top Slab. Each top slab shall be placed in the manner described for the bottom slab.

3. No two abutting sections shall be placed within a period of 48 hours, unless otherwise authorized by Engineer.

L. Duct Banks

1. Duct bank concrete shall be compacted by rodding or spading only. Mechanical vibrators shall not be used. Concrete shall be worked around reinforcement and embedments and into the corners of the forms.

3.3 COMPOSITE TOPPING CONCRETE

A. Composite topping concrete (Class D6) shall be placed in the locations indicated on the Drawings.

B. Surface Preparation

1. Before topping is applied, the underlying hardened concrete surface shall be scrubbed clean. Grease or oil shall be completely removed by cleaning the surface in accordance with ASTM D4258 and abrading the surface in accordance with ASTM D4259 by chipping or grinding. The cleaned surface shall be rinsed with clean water and kept saturated for the 24 hour period immediately preceding the application of topping. Immediately before topping is applied, the hardened concrete shall be coated with epoxy bonding agent or with neat portland cement slurry having the consistency of paint.

C. Composite Topping

1. Composite topping concrete shall be applied over the precast or cast-in-place concrete roof areas indicated on the Drawings. Topping shall be spread and compacted with suitable concrete tools. Topping shall be accurately placed to the elevations and slopes indicated.

3.4 CLEANING EMBEDMENTS

A. Embedments shall be clean when installed.

End of Section

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SECTION 03 35 00 - CONCRETE FINISHING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers finishing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly finished as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products and concrete ingredients supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Proposed repair materials and procedures for defects in concrete that are more than 3 inches [75 mm] deep, submitted only after such repairs are found to be necessary.

PART 2 - PRODUCTS

2.1 MATERIALS

Concrete Surface Coloring/Hardener	Mineral aggregate dry-shake colored hardener for concrete flatwork. ChemSystems, Inc. "CSI Color Hardener," Euclid "Surflex," Dayton Superior "Quartz Tuff, " or SpecChem "Quartz Floor Hardener."
Evaporation Reducer	Dayton Superior "AquaFilm Concentrate J74," Euclid "Eucobar," L&M Chemical "E-Con," Master Builders Solutions "MasterKure ER50," Sika "SikaFilm, " or SpecChem "SpecFilm."

Colloidal Silica Finishing Aid	Dayton Superior “Superior Finishing Aid”, W.R. Meadows “Finish-Assist Pro”, or Solomon “Day1”.
Nonslip Aggregate	Aluminum oxide aggregate, L&M Chemical “Grip It,” Master Builders Solutions “MasterTop 120SR,” or Dayton Superior “Emery Non-Slip.”
Floor Sealer	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3.1 FINISHING UNFORMED SURFACES

A. Buried and permanently submerged concrete blocking and encasement will require no finishing except as necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

B. Screeding

1. Screeding shall produce a concrete surface conforming to the proper elevation and contour, with all aggregates completely embedded in mortar.

C. Application of Evaporation Reducer

1. Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight; or if bleed water sheen is not visible on the concrete surface after strike-off and initial floating; shall be protected with an evaporation retarder unless subsequent finishing operations can commence. The evaporation retarder shall form a continuous film on the surface of fresh, plastic concrete. Follow ACI 308.1-23 Section 3.2; “evaporation retarder” is synonymous with “evaporation reducer.”

2. Immediately following screeding, evaporation reducer shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon , in accordance with the manufacturer’s recommendations. The spray equipment shall have sufficient capacity to continuously spray the product at approximately 40 psi with a suitable nozzle as recommended by the manufacturer.

3. The sprayable solution shall be prepared as recommended by the manufacturer.

4. The evaporation retarder shall not be worked into the surface and shall not be used as a finishing aid. Evaporation retarder shall be allowed to fully evaporate prior to subsequent finishing operations.

5. Under severe drying conditions, additional applications of evaporation reducer may be required following each floating or troweling, except the last finishing operation.

D. Floating

1. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

2. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color, and unless additional finishing is specifically required, shall produce the completed finish for unformed surfaces.

3. Floating shall be done with hand floats or suitable mechanical compactor-floats.

E. Finishing Surfaces for Bonding

1. All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flat surfaces to receive composite topping (Class D6) shall be given a broom finish or raked finish with at least a 1/4 inch profile.

F. Troweling

1. Interior floor surfaces which will be exposed after construction is completed; surfaces to be covered with resilient floor coverings, thinset terrazzo, or seamless floor covering; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the Drawings shall be steel trowel finished. Surfaces to be covered with elastomeric deck covering shall be lightly troweled but not burnished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

2. Air-entraining admixture may be omitted from concrete for interior floor surfaces which are to be steel trowel finished.

3. If desired for ease of finishing, use of a colloidal silica finishing aid during troweling is permitted. This product shall not be used as an evaporation retarder. Silicate based products used as finishing aids shall not be permitted.

4. Concrete floors that extend both inside and outside an exterior wall, and have no construction joint to delineate the areas, shall include the air entraining admixture if it is specified in the Cast-in-Place Concrete section. The exterior portion of the

floor shall receive a broom finish as indicated herein, and the interior portion shall be lightly troweled, but not burnished.

G. Edging

1. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having at least a 1/8 inch corner radius.

H. Broom Finish

1. Concrete surfaces indicated below shall be given a light broom finish to produce a nonslip surface. Brooming shall be done after the second floating and at right angles to the normal direction of traffic.

2. Broom finish shall be provided at the following locations:

a. Interior or exterior walkways around basins

b. exterior stairs

I. Pavement Finishing

1. The surface of pavements shall not vary more than 1/8 inch under a 10 foot straightedge placed parallel to the center line.

2. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be drag finished, using a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap and shall have sufficient length in contact with the concrete to slightly groove the surface. The drag shall be moved forward with a minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. When acceptable to Engineer, carpet, artificial turf, or cotton fabric may also be used.

3. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be broom finished with a broom acceptable to Engineer. The broom shall be not less than 18 inches wide and made from good quality bass or bassine fibers not more than 5 inches long. The broom finishing shall produce regular corrugations not over 1/8 inch deep. The broom shall be pulled square across the surface, from edge to edge, with adjacent strokes slightly overlapped, and shall not tear the concrete surface.

4. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be grooved in the transverse direction, using a wire broom or comb with a single row of tines. Unless otherwise permitted by Engineer, the grooving shall be at least 1/8 inch wide at 3/4 inch centers and the groove depth shall be approximately 1/8 inch . The transverse grooving shall terminate approximately 1 foot from the gutter line at the base of the curb. The area adjacent to the curb shall be given a light broom finish longitudinally.

J. Sidewalk Finishing

1. Concrete surfaces shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. Initial floating shall be followed by a second floating at the time of initial set.

2. Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be done at right angles to the length of the walk.

3. Sidewalks shall be edged using a 3 or 4 inch wide edging tool with a 1/8 inch corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be provided at right angles to the length of the walk, using a grooving tool with 1/8 inch radius. The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.

4. The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.

3.2 CONCRETE SURFACE COLORING/HARDENER

A. Where concrete surface coloring/hardener is required, a dry-shake coloring material shall be worked into the freshly screeded concrete surface.

B. Duct Bank Finishing

1. After screeding and before final floating, a red concrete surface coloring shall be dusted onto the fresh concrete surface at the rate recommended by the manufacturer.

C. Floor Finishing

1. Where concrete surface coloring/hardener is required on the Drawings, the coloring material shall be applied at the rate of 50 lbs per 100 square feet in strict accordance with the manufacturer’s recommendations. The color of the concrete surface shall be as required on the Drawings.

2. Concrete floors with surface coloring shall be protected from damage until acceptance by Engineer. Areas which are subject to traffic or over which equipment or materials are to be moved shall be covered with hardboard or plywood. Just before final inspection, the colored floors shall be thoroughly cleaned and then waxed with colored wax furnished by the manufacturer of the coloring material.

3.3 FLOOR SEALER

1. All concrete floors in interior locations which are to remain as exposed concrete or will be covered with carpet shall be given two coats of clear floor sealer in addition to any which may have been applied as a membrane curing compound. Floor sealer shall not be applied to concrete floors that are to be stained or etched, covered with chemical resistant linings, covered with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material. Prior to application of each coat of sealer, the floor shall be thoroughly cleaned of dirt, grease, and other foreign matter. The first coat shall be applied at the end of the curing period. The second coat shall be applied in preparation for substantial completion of the work. Floor sealer shall be applied in accordance with the manufacturer's recommendations.

3.4 REPAIRING DEFECTIVE CONCRETE

A. Defective concrete shall be defined as any surface with undesirable visible effects in excess of that permitted by the relevant formed concrete surface category (CSC), except as indicated otherwise herein.

B. Defects in formed concrete surfaces shall be repaired to the satisfaction of Engineer within 24 hours of form removal. Surface repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of the surrounding concrete. Surface repair material shall be adequately cured.

C. For unformed surfaces, defective concrete, including weak surfaces, shall be defined and repaired as follows:

1. Mortar rich surfaces are defined as being deficient in plus U.S. No 4 (4.75 mm) sieve size aggregates.

2. Rain damaged surfaces are defined as surfaces with coarse aggregate exposed at the surface, concrete surfaces containing carbonation to a depth greater than 1/8 inch when cores are evaluated by a qualified petrographer, or concrete surfaces having a Moh's hardness of less than 2, when tested in accordance with ASTM C1895.

3. Improperly cured surfaces, honeycombed surfaces, or surfaces containing deleterious materials.

4. Surfaces with any of these conditions shall be repaired by diamond grinding and application of surface repair materials. High impact removal processes that cause micro-cracking (i.e., bruising) shall not be used. Contractor shall submit a proposed repair material and procedure for review and acceptance by Engineer.

D. Defects in concrete that are more than 3 inches deep shall be brought to the attention of Engineer prior to any repair work. Contractor shall submit a proposed repair material and procedure for review by Engineer. The repair material and procedure required by Engineer may be more extensive than the process described in Article 5.3.7 of ACI 301.

3.5 FINISHING FORMED SURFACES

A. Formed concrete surfaces shall meet all criteria of the relevant formed concrete surface category (CSC), as defined in ACI 347.3R, except as indicated otherwise herein. Surfaces shall be assigned to CSCs as indicated.

B.

Formed Concrete Surface Category	Applicable Surfaces	Mockup Required
CSC1	Formed concrete surfaces that will be in permanent contact with earth backfill.	No
CSC2	All other formed concrete surfaces not designated otherwise.	No
CSC3	None.	Yes
CSC4	None.	Yes

C. Fins, form seams, and construction joints shall be ground flush on all surfaces in formed concrete surface categories CSC2, CSC3, and CSC4, and in CSC1 surfaces that are required to be dampproofed.

D. All tie holes in formed surfaces, regardless of the relevant CSC, shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and cured and shall match the texture and color of the adjacent concrete.

E. Concrete surfaces to be dampproofed shall have fins removed and tie holes filled, but no additional finishing will be required.

F. Concrete surfaces to be painted or grout cleaned shall have sharp edges and projections removed to provide an acceptable condition for painting or grout cleaning. The concrete surfaces shall have bug holes filled per the Protective Coatings section.

G. Mockups

1. Mockups shall be used to validate the means and methods to be used by Contractor, and to provide Owner a sample of the specified concrete surface. The use of a reference area within an existing structure shall not be acceptable as a mockup.

2. Mockups shall incorporate the structure geometries; reinforcing bar size, spacing, arrangement, and cover; inserts; the approved concrete mixture; sample tie hole patching, and other likely required repair procedures. Contractor shall confirm in writing that the mockup quality represents work than can be accomplished in the actual structure.

H. Grout Cleaning

1. The surfaces noted on the Drawings shall be finished by grout cleaning.

2. Grout-cleaned finish shall conform to Paragraph 5.3.3.3.b of ACI 301. Grout cleaning shall not result in an overall plastering of the concrete surfaces, but shall produce a smooth, uniform surface free of marks, voids, surface glaze, and cement dust.

3.6 TOLERANCES

A. Tolerances for cast-in-place concrete work shall be as stipulated in ACI 117, unless otherwise indicated.

B. Settling Basin Tolerance

1. Settling basin floors shall be accurately finished to a uniform slope, and shall be within 1 inch of the shape indicated on the Drawings.

C. Ringwall Tolerances

1. The top of the foundation ringwall for each steel reservoir shall be accurately constructed within the following tolerances:

   a. In any 30 foot length, the top of the wall shall not vary from level by more than 1/4 inch peak to valley.
   b. No two points on the top of the wall shall differ in elevation by more than 1/2 inch .

2. Levels will be checked on the top of the foundation wall, and any variations exceeding the specified tolerances shall be corrected prior to erection of the reservoir.

D. Flat Member Mounting Tolerances

1. Formed concrete surfaces that are to have a face-mounted flat steel or FRP member attached, including but not limited to items such as weir plates or shelf angles, shall have a profile that permits the installation of the flat member without grinding the concrete surface (except for removal of fins), deforming the flat member, or requiring usage of backer rods or shims.

3.7 COMPOSITE TOPPING CONCRETE

A. Composite topping shall be screeded and floated with suitable concrete tools. Topping shall be given a float finish.

3.8 CLEANING EMBEDMENTS

A. After placement of concrete, surfaces of embedments not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

End of Section

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SECTION 03 39 00 - CONCRETE CURING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers curing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly cured as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

A curing plan, indicating the planned method and duration of curing for each individual structure on the project.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Concrete shall be cured in a manner that will minimize shrinkage and cracking as specified herein.

2.2 MATERIALS

Membrane Curing Compound	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3.1 GENERAL

A. Cold Weather Concreting

1. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

2. The concrete surface shall be maintained at a temperature of at least 50° F for 5 days or 70° F for 3 days, after placement. Concrete temperature shall be recorded at least six times for each 24 hour period. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

B. Hot Weather Concreting

1. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

2. At air temperatures of 90° F or above, concrete shall be kept as cool as practicable during curing.

3. Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented.

3.2 CURING

A. Concrete shall be protected from loss of moisture for at least 7 days after placement unless indicated otherwise. Curing of concrete shall be done by methods which will keep the concrete surfaces adequately wet for the specified curing period.

B. Water Curing

1. Water curing shall be performed for concrete in liquid-containing structures and for all concrete containing slag cement. Other forms of curing will not be acceptable in these applications. Water curing shall be in accordance with ACI 308.1 except as modified herein.

2. Water saturation of concrete surfaces shall begin as soon as possible after initial set. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

3. Water curing shall continue for 14 days for concrete containing slag cement, and for 7 days for other types of concrete. However, when concrete is being protected from low temperatures, the duration of water curing may be shortened to 1 day less than the duration of cold weather protection.

4. When forms are removed before the specified curing duration is completed, measures shall be taken to immediately continue water curing and to provide adequate thermal protection for the concrete.

C. Membrane Curing

1. Unless otherwise specified, membrane curing compound may be used instead of water curing on concrete in non-liquid-containing structures which will not be stained or etched, covered with chemical resistant linings, covered with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material.

2. Membrane curing compound shall be evenly sprayed at a coverage rate of not more than 300 square feet per gallon . The spray equipment shall have sufficient capacity to continuously spray curing compound at approximately 40 psi with a suitable nozzle as recommended by the manufacturer. Unformed surfaces shall be covered with the first coat of curing compound within 30 minutes after final finishing. A second coat of curing compound shall be applied when the first coat has become tacky to the touch and shall be applied at right angles to the first coat.

3. Curing compound shall be suitably protected against abrasion during the curing period.

D. Film Curing

1. Unless otherwise specified, film curing with white polyethylene sheeting may be used instead of water curing on concrete in nonliquid-containing structures which will be covered later with mortar or additional concrete, or which will otherwise not be exposed to view.

2. Film curing shall begin as soon as possible after initial set of the concrete. The concrete surfaces shall be completely covered with polyethylene sheeting. Sheeting shall overlap the edges of the concrete for proper sealing and anchorage, and joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and as necessary to prevent billowing on the surface.

End of Section

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SECTION 03 41 00 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design, fabrication, and erection of prestressed, precast concrete members of hollow core construction for roof and floor applications. Precast concrete wall panels are covered in other sections.

1.2 GENERAL

A. Structural precast concrete members shall be furnished and installed complete with all embedments, accessories, and special construction as specified and as indicated on the Drawings.

B. Layouts and details are based on members of the widths indicated on the Drawings. Precast manufacturer may propose alternate member widths for consideration by Engineer.

1.3 QUALIFICATIONS

A. Manufacturer

1. The precast concrete manufacturing plant shall be certified under the PCI Certified Plant Program. The manufacturer shall be certified at the time of project bidding. Certification shall be in the following product categories:

a. Category C2, C3, or C4 for production of hollowcore members.

B. Erector

1. The precast concrete erecting crew shall be qualified under the PCI Erector Qualification Program, Category S1 or S2.

1.4 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

Items required to verify the concrete mixture:

Reports covering source and quality of concrete materials.

Test reports showing compressive strength of each design mix.

Reports for required testing during member production.

Information on plant capability, productivity, quality assurance program, and manufacturing equipment and procedures.

PCI Certification of the manufacturer's plant.

PCI Certification of the erector.

C. The following items shall be submitted bearing a seal by a Professional Engineer licensed in the state where the members will be erected. The seal shall be by a registered Structural Engineer if required by that state.

Complete drawings and data covering fabrication, layout, and installation.

Complete design calculations for precast members and connection elements.

Limitations for field cutting or other modifications to members after arriving at the project site.

All loads used in the design of members.

Details of sections where concentrated loads are to be applied and where boxouts are provided, including saddles, headers, and other special supports.

Letter or certification confirming that all products have been designed and fabricated in accordance with the Contract Documents. This document shall qualify as the "Fabricator's Certificate of Compliance" required in the Code Required Special Inspections and Procedures section.

A confirmation statement that the special inspection and testing requirements indicated in the Code Required Special Inspections and Procedures specification are sufficient. Any additional special inspection or testing required by the delegated designer shall be submitted to Engineer for inclusion into the special inspection program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prestressed concrete members shall not be damaged during handling and shall only be in contact with adjacent concrete members when designed for such conditions. Members shall be stored on timber skids or dunnage, and leveled to avoid twisting or other undesirable stresses. Members shall not be moved from the manufacturer's yard until reaching a sufficient strength as

determined by the manufacturer. The manufacturer shall be responsible for the condition of prestressed members until they are removed from the delivery vehicle at the Site.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Precast concrete members, including embedments and accessories, shall be designed for the loads, service conditions, codes, and criteria specified herein and as indicated on the Drawings.

B. Codes and Standards

1. Except as otherwise specified herein, design, fabrication, and installation shall comply with all applicable provisions of the following:

a. Building code(s) and local amendments indicated in the Meteorological and Seismic Design Criteria section.
b. 2021 International Building Code.
c. ACI 318-19, "Building Code Requirements for Structural Concrete."
d. ACI 550.5, "Design of Precast Concrete Diaphragms for Earthquake Motions."
e. PCI MNL-116, "Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products."

C. Design Criteria

1. The following requirements shall apply to the prestressed concrete:

a. The maximum size of aggregate shall be 3/4 inch .
b. The maximum size of prestressing strand shall be 0.6 inches .
c. For all members, the maximum flexural tension in the precompressed tensile zone under applied dead load plus live load shall be:
1) 3 x sqrt f'c, psi

d. Members shall be designed for the loadings, penetrations, and configurations indicated on the Drawings.
e. Installed camber shall exceed total deflection caused by superimposed dead load and longtime effects of shrinkage and creep.
f. Adjacent members shall have approximately the same camber.
g. Immediate deflection of members due to live load shall not exceed span/480.
h. Members shall have embedments and additional reinforcing to satisfy support and anchorage details.
i. Manufacturer shall design and detail connections in general accordance with the configurations indicated on the Drawings. Connection design shall satisfy all applicable requirements of the building code. The "Basic Design Option" of ACI 550.5 has been used, and moderate or high deformability connection elements shall be incorporated into the work.

j. For cases where the precaster is designing an entire precast concrete building, including roof, walls, columns, etc., the design option of ACI 550.5 (either Elastic Design Option, Basic Design Option, or Reduced Design Option) and the deformability of roof diaphragm connection elements shall be selected by the delegated designer.

2.2 MATERIALS

A. Materials for the prestressed members shall be new and free from defects, and shall meet the following requirements unless indicated otherwise on the Drawings. All materials shall be suitable for prestressed concrete construction.

Prestressing Strand	ASTM A416.
Reinforcing Steel	ASTM A615, Grade 60, deformed.
Deformed Bar Anchors (DBA)	ASTM A1064 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson division or equal.
Headed Concrete Anchors	ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson division or equal.
Steel Embedments and Accessories	
Shapes and Plates	ASTM A36, galvanized.
Bolts and Nuts	
High Strength	ASTM F3125, Grade A325.
Unfinished	ASTM A307.
Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat	ASTM F844.
Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436.
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator; type compatible with bolts tested in accordance with Article 10.2 of ASTM F959.
Stainless Steel Embedments and Accessories	
Plates	ASTM A240, Type 316L.

Shapes	ASTM A1069 or A276, Type 316L
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.
Galvanizing	Hot dipped, G90, in accordance with ASTM A123, A153, A385, and F2329.
Concrete	Minimum compressive strength of 5,000 psi at 28 days.
Cement	ASTM C150, Type I or Type III.
Aggregates	ASTM C33 or C330, non-reactive as determined by ASTM C1778.
Water	Clean and free from deleterious substances.
Bearing Pads (Elastomeric)	Elastomeric Isotropic Random Oriented Fiber Reinforced Pad; JVI Inc. “Masticord” or Voss Engineering “Fiberlast.”
Bearing Pads (Hardboard)	ANSI/AHA A135.4, Class 1, tempered hardboard.
Expansion Joint Filler	Preformed sponge rubber, ASTM D1752, Type I.
Topping Slabs	As indicated on the Drawings and as specified in the Cast-in-Place Concrete section.
Mortar (for grouting precast hollow core concrete members)	Minimum compressive strength of 3,000 psi at 28 days, unless indicated otherwise on the Drawings.
Cement	ASTM C150, Type 1.
Sand	ASTM C404, natural sharp sand.
Leveling Mortar	Sika “SikaSet Mortar,” unless indicated otherwise on the Drawings.
Water	Clean and free from deleterious substances.

2.3 MANUFACTURE

A. Configuration

1. Members shall be rigid, adequately braced, and free from dents, gouges, or other irregularities which would impair the quality, appearance, or performance of the members.

2. The side edges of cored members shall have a continuous grout key. The beam (soffit) of the side edges shall be rounded or have an angled chamfer.

B. Release of Tension

1. The concrete shall attain a compressive strength of at least 3,500 psi before the pretensioning stress in the prestressing strands is released.

C. Embedded Accessories

1. All plates, inserts, and other accessories which are required to be embedded in the members shall be installed at the time of manufacture. All embedded items shall be accurately positioned and shall be rigidly held in position during concrete placement. It is essential that bearing plates be installed in exact and true position.

D. Openings and Inserts

1. Openings for roof ventilators, skylights, roof drains, and other items as indicated on the Drawings shall be incorporated into the design and fabrication. The Drawings shall be carefully reviewed for the openings and inserts required by the work of all trades, and all openings and inserts which are beyond the limitations of field modification shall be provided by the manufacturer. Side edges of openings shall be formed or cut neatly and shall have vertical surfaces. Saddles, headers, or other suitable supports shall be provided by the manufacturer as necessary for the size and location of openings.

2. The manufacturer's submittals shall state the limitations for field cutting or modification.

E. Ends of Strands

1. Protruding ends of prestressing strands shall be cut off flush with the concrete and coated or finished to prevent rusting.

F. Surface Finish

1. The top surface of horizontal members shall be given a smooth float finish or machine cast unless specifically indicated otherwise on the Drawings.

2. Formed surfaces shall have a smooth uniform or machine cast texture and color. All fins and other projections shall be removed from formed surfaces, and all holes and other surface defects shall be repaired to the satisfaction of Engineer.

G. Shop Markings

1. Each member shall have shop markings, painted or labeled at a place not exposed to view after installation, to indicate location and position in the structure in accordance with the manufacturer's layout drawings.

H. Bearing Pads

1. Bearing pads shall be used where indicated on the Drawings or in accordance with the manufacturer's typical connections details as accepted by Engineer.

2.4 CEMENTITIOUS MATERIALS FOR ERECTION

A. Topping Slab Concrete

1. Topping slab concrete shall be batched and delivered in accordance with the Cast-in-Place Concrete section.

B. Mortar (For Grouting Precast Hollow Core Members)

1. Mortar for grouting precast hollow core members shall be fine or coarse concrete grout meeting the requirements of ASTM C476. Only enough water shall be added to produce a mixture which is flowable, but which will not show an excess of water when placed. Unless otherwise specified, mortar shall have a slump ranging from 8 to 11 inches .

2.5 CURING

A. Concrete shall be cured by continuous surface saturation or inundation, exposure to steam or saturated air in a tightly closed room or chamber, or other method acceptable to Engineer. Moist curing shall be maintained for at least 7 days when Type I cement is used, or 48 hours when Type III cement is used. The steam curing period shall be as needed to reach minimum compressive strength.

2.6 TOLERANCES

A. Tolerances for prestressed concrete members shall be as recommended by PCI MNL-116, Division VI.

B. Prestressed members will be rejected for any of the following:

1. Length variation in excess of 1/2 inch (1/4 inch each end) of adjacent units or 1 inch maximum between the longest and shortest units.

2. Edges varying in excess of specified tolerance criteria.

3. Deviation from differential camber between adjacent members of the same design, or warp or camber which cannot be controlled by the fastening system between members.

4. Improperly placed accessories or boxouts.

5. Unsatisfactory surface finish.

6. Exposure of wire mesh, reinforcing steel, or prestressing strand, except where cut off at the ends.

7. Honeycomb.

8. Fractures, cracks, chips, or spalls which cannot be repaired to the satisfaction of Engineer.

9. Irregularities resulting from damaged forms.

2.7 TESTING

A. Six concrete compression test cylinders shall be cast each day of concreting operations. An additional set of six cylinders shall be cast each time there is a change in the concrete mixture during the day's operations. Control test specimens shall be tested as necessary to determine when to transfer stress from the temporary end anchorage to the bond in the concrete. At least two cylinders from each set shall be tested at an age of 28 days.

B. Each concrete mixture shall be tested at least once each week, minimum of one test, for water-soluble chloride ion in accordance with ASTM C1218. Maximum water-soluble chloride ion concentrations in prestressed, hardened concrete at an age of 28 days shall not exceed 0.06 percent expressed as a percentage of mass of cement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Installer shall have been regularly engaged for at least three years in the installation of precast structural concrete similar to the requirements of the Project. Prestressed concrete members shall be set in position in accordance with the manufacturer's layout and the Drawings. Members shall not be placed onto concrete or masonry structural elements until those elements have attained their specified 28 day compressive strength. Bearing pads shall be installed as indicated on the design and fabrication drawings. Members shall rest solidly upon the supports, without rocking.

B. Hollow Core Slabs

1. Members in final position shall be leveled as necessary so that adjacent bottom edges are even, and the grout keys shall be filled with mortar. Mortar dams shall be provided at

openings and other locations as necessary to prevent mortar leakage. Leveling loads shall be left in place until the mortar has attained sufficient strength to withstand the shear loads. All mortar that seeps through the joint shall be removed before it hardens.

2. When all members have been placed, the joints filled with mortar, and the leveling loads removed, the members shall be anchored to the supports as indicated on the Drawings.

C. Welding

1. If welded connections are required, welding shall be done by qualified welders possessing valid certificates under the qualification procedures of AWS D1.1. Care shall be exercised to avoid overheating and cracking the concrete adjacent to the anchorage plates. All members damaged during welding shall be removed and replaced by the Installer with new, undamaged members at no additional cost to Owner.

D. Field Cutting

1. Openings, within the manufacturer's limitations and not requiring cutting of prestressing strands, shall be cut in the field in accordance with the manufacturer's standard recommendations. Openings requiring cutting of prestressing strands shall only be permitted when the precaster’s delegated design engineer has incorporated the cutting into the design.

2. All cutting of concrete sections shall be done with suitable concrete saws or core drilling equipment in a manner that will provide smooth, even cut surfaces. Side edges of openings shall have vertical surfaces.

3. All lifting loops shall be cut off flush with the top surface of the member before any covering materials are placed.

E. Joints

1. The soffit of all members shall present a neat and uniform appearance.

2. When installing hollow core members, cementitious mortar shall be firmly placed by methods which will ensure complete, uniform, and permanent filling of the entire space without disturbing or displacing the adjacent members.

3. When insulation is required to be installed directly on the roof slab, all joints shall be checked for unevenness before roofing materials are placed over the prestressed members. Where the top edges of adjacent members deviate more than 1/4 inch from a flush surface, leveling mortar shall be placed along the edge to eliminate the sharp offset. The mortar shall slope uniformly not steeper than 1/2 inch vertically to 12 inches horizontally from the high edge to the surface of the adjacent member.

4. The underside of joints that will be permanently exposed to view after the work has been completed shall be caulked. Caulking requirements, and the areas to be caulked, are covered in the Caulking section.

F. Topping Slabs

1. All joints and other locations which could leak liquid topping shall be sealed or dammed prior to placement. Topping slab concrete shall be placed finished and cured in accordance with the cast-in-place concrete section.

G. Repairs After Erection

1. Surfaces damaged during handling or erection, and areas from which fins and projections have been removed, will be repaired to a uniform finish that will blend in with the rest of the member. All repairs shall be accomplished to the satisfaction of Engineer.

End of Section

SECTION 03 45 00 - ARCHITECTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design, fabrication, and erection of architectural prestressed, precast concrete (insulated or solid panels) for wall applications for the Chemical Feed Building . For structural precast concrete hollow core members refer to the Structural Precast Concrete specification section. For grouting of architectural precast concrete components refer to the Grout specification section. For caulking of architectural concrete components refer to the Joint Sealants specification section.

1.2 GENERAL

A. Architectural precast concrete members shall be furnished and installed complete with all embedments, accessories, and special construction as specified and as indicated on the drawings.

B. Layouts and details are based on members of the widths indicated on the Drawings. Members with a different standard width will need to be approved by the Engineer.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted bearing the seal of a Professional Engineer registered in the state of Alabama qualified in the design of architectural precast concrete.

1. Calculations, including all loads indicated in the Contract Documents.

2. Graphics showing where concentrated loads are applied.

3. Complete drawings and data covering fabrication, layout, and installation.

4. Limitations for field cutting or modifications.

5. Fabrication drawings shall include:

    a. All architectural features including formliners, rustications, finishes, chamfers and joints.
    b. Reinforcing sections indicating the location and type of reinforcement for each unit.
    c. Boxouts, saddles, headers, embedded plates, corbels, brackets, and other special supports.
    d. Details of sections where concentrated loads are to be applied.

e. Details of connections where adjacent units are to be supported.
f. Connection locations, and any required accessories and hardware.

6. Erection drawings shall include:

a. Each individual piece mark, erection sequence, and details necessary to properly install each precast unit.
b. Details indicating proper handling and erection, including all erection accessories and hardware.
c. Connection details.
d. Required bracing during erection for temporary construction conditions.
e. Proposed type of anchors and points of anchorage for temporary bracing, whether to permanent construction or to a point outside the structure(s).
f. Limitations for field cutting or modifications.
g. Erection drawings shall indicate all architectural features including formliners, rustifications, and finishes. Chamfers and joints shall be indicated on the erection drawings. The preliminary building renderings for the Chemical Building used Fitzgerald Formliners "Fluted Rib" formliner pattern #14322. Final formliner pattern will be selected during the submittal review phase by the Engineer and Owner.

7. Specifications for required welding procedures and welder certifications, for welding that will occur in the manufacturer's facilities or at the project site. If fabricated assemblies are to be supplied to the manufacturer by an outside fabricator, welding certifications shall be provided by the manufacturer for each fabricated assembly.

8. Letter or certification confirming that all products have been designed and fabricated in accordance with the Contract Documents. This document shall qualify as the "Fabricator's Certificate of Compliance" required in the Code Required Special Inspections and Procedures section.

9. A confirmation statement that the special inspection and testing requirements indicated in the Code Required Special Inspections and Procedures specification are sufficient. Any additional special inspection or testing required by the delegated designer shall be submitted to Engineer for inclusion into the special inspection program.

C. The following items shall be submitted, as a minimum.

1. Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Items required to verify each unique concrete mixture:

a. Reports covering source and quality of concrete materials.
b. Test reports showing compressive strength of each design mix.
c. Reports for required testing during member production.

3. Information on plant capability, productivity, quality assurance program, and manufacturing equipment and procedures.

4. PCI Certification of the manufacturer's plant.

5. PCI Certification of the erector.

6. Samples of the following, in a 12 inch by 12 inch size, and appropriate thickness.

   a. Three samples for each type of concrete and finish to be used.

7. Mockups, as described in the Samples and Mockups paragraph herein.

1.4 MANUFACTURER'S QUALIFICATIONS

A. The manufacturer of the architectural precast concrete units shall submit evidence of the following:

1. Manufacturer shall be designated as a PCI-certified plant for Category AC at the time of bidding.

2. Information on present plant capability, production, quality assurance program, and manufacturing equipment and procedures.

3. Adequate facilities to fabricate the required components in the required construction period.

4. Current year certification of the manufacturer by the Precast/Prestressed Concrete Institute (PCI).

5. Manufacturers shall be certified by PCI according to PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products" or certified according to PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products" with certification of providing architectural finishes according to PCI MNL 117.

6. Business operation as a manufacturer of precast and precast/prestressed concrete products for not less than (5) years in each product type to be required.

1.5 SAMPLES AND MOCK-UPS

A. Samples shall be submitted for review and shall include:

1. Samples of architectural precast wall panel finishes to be used on the project.

2. Three samples for each type of concrete and finish to be utilized in the manufacture for review of color, finish, formliner, pattern, and texture prior to commencement of manufacture.

3. Samples shall be 12 inches by 12 inches in size and of appropriate thickness.

B. For each product type, mock-ups shall be provided to the project site for review and prior commencement of manufacture. Mock-ups shall comply with the following:

1. Two mock-ups shall be produced simultaneously and shall indicate architectural and structural features including but not limited to:

a. Cast-in accessories and embedded items.
b. Chamfers, edges, and rustifications.
c. Colors, finishes, formliners, patterns, and textures.

2. Mock-ups shall be representative of architectural precast units produced and shall be of appropriate size to adequately indicate the size and proportion of architectural finishes.

3. For each product type, one approved mock-up shall be maintained at the project site and one approved mock-up shall be maintained at the manufacturer’s facilities to verify architectural precast units delivered to the project site match the approved architectural precast concrete mock-ups.

4. Any architectural unit not matching the approved mock-up at the project site shall be rejected and a new, undamaged architectural precast unit shall be provided at no additional cost.

5. Mock-ups may be permitted to be full-size and upon approval by the Engineer may be incorporated into the actual product delivered to the project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer will be responsible for the condition of prestressed members until they are removed from the delivery vehicle at the site.

B. Delivery

1. Architectural precast concrete units shall be delivered to the project site free of dirt, stains, or damage. Members shall not be moved from the Manufacturer's yard until completion of the specified curing period and have attained the specified concrete strength by the manufacturer’s engineer for transportation and erection.

C. Storage

1. Members shall be stored on timber skids and leveled to avoid twisting or other undesirable stresses. Nonstaining resilient blocking and spacers shall be used between the ground and/or units for both transportation and storage. Architectural precast units utilizing cores shall be protected from the elements to prevent trapping of moisture in the cores.

D. Handling

1. Units shall be lifted and supported during manufacture, storage, transportation, and erection only at the lifting or support location as determined by the manufacturer's engineer. Architectural precast concrete members shall not be damaged during handling and shall be kept from contact with adjacent concrete members.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Architectural precast concrete shall be suitable for the service conditions as specified and as indicated on the drawings. Members, including embedments and accessories, shall be designed in accordance with the following performance and design requirements.

B. Codes and Standards

1. Except as otherwise specified herein, design, fabrication, and installation shall comply with all applicable provisions of the following:

a. Building code(s) and local amendments indicated in the Meteorological and Seismic Design Criteria section.
b. ACI 318-19, American Concrete Institute, "Building Code Requirements for Structural Concrete".
c. ASCE 7-16, American Society of Civil Engineers, "Minimum Design Loads for Buildings and Other Structures".
d. PCI MNL-116, Prestressed Concrete Institute, "Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products".
e. PCI MNL-117, Prestressed Concrete Institute, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products".
f. 2021 International Building Code, International Code Council.

C. Fire Rating

1. Members shall have a fire rating as indicated on the drawings. Units requiring a fire rating greater than 1 hour shall have an Underwriter's Laboratories label permanently attached to the members and within view for verification by the Building Code Official

D. Performance and Design Requirements

1. The following requirements shall apply to the prestressed concrete:

a. The maximum size of aggregate shall be 3/4 inch.
b. The maximum size of prestressing strand shall be 1/2 inch.
c. For all members, under dead load conditions (the dead load of the member plus the required superimposed uniform dead load), there shall be no flexural tension in the precompressed tensile zone.

d. Members shall comply with Chapter 24 of ACI 318 and designed as Class U – Uncracked with the maximum flexural tension in the pre-compressed tensile zone under applied dead load plus live load not exceeding 3 x sqrt f'c, psi.
e. Connections and all exposed embedded hardware and embedded items shall be hot-dipped galvanized.
f. For all members, members shall comply with Table R24.5.2.1 - Serviceability Design Requirements of ACI 318. For all precast members, the required strength of the members shall meet the requirements of ACI 318.
g. Members shall be designed for the loadings, penetrations, and configurations indicated on the drawings and in the Meteorological and Seismic Design Criteria section.
h. Immediate deflection of members due to live load shall not exceed span/480.
i. Members shall have embedments and additional reinforcing to satisfy support and anchorage details.
j. Manufacturer shall design and detail connections in general accordance with the configurations indicated on the drawings. Connection design shall satisfy all applicable requirements of the building code.
k. Members shall be designed for the required fire rating.
l. Hollow Core Roof
    1) Design and detail hollow core slab (Refer to Precast Structural Concrete Specification) to precast wall panel connections to transfer required diaphragm forces and provide a continuous lateral load path.

m. Precast Concrete Panel
    1) Members shall be designed to support vertical loads including eccentricities.
    2) Members shall resist out of plane lateral loading including wind and seismic loading
    3) Members shall resist in plane lateral loading including wind and seismic loading

n. Connections
    1) Design and provide connections for interface between precast wall panel and hollow core slab. Precast connections shown on drawings are conceptual.
    2) Design connections to allow rotation and/or movement to avoid damage to other members, joints, and other building accessories.
    3) Design and provide connections to cast-in-place concrete that is not fully shown on drawings. Ensure compatible and practical connection.

2.2 MATERIALS

A. Materials for the prestressed members shall be new and free from defects, and shall meet the following requirements unless indicated otherwise on the design drawings. All materials shall be suitable for prestressed concrete construction.

Prestressing Strand	ASTM A416.

Reinforcing Steel	ASTM A615 or A706, Grade 60, deformed. Reinforcing steel shall conform with the requirements in ACI 318 Table 20.2.2.4a.
Welded Wire Fabric	ASTM A1064, Grade 70.
Deformed Bar Anchors (DBA)	ASTM A1064 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson division or equal.
Headed Concrete Anchors	ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson division or equal.
Embed Channels and T-Bolts	Halfen Embed Channels and T-bolts, Hot-dip galvanized, as noted on the Drawings
Stainless Steel Embedments and Accessories	
Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI/ASME B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.

Concrete	Minimum compressive strength of 5,000 psi at 28 days. Minimum precast (not prestressed) release and stripping compressive strength of 3,000 psi. Minimum precast/prestressed release and stripping compressive strength of 3,500 psi.
Cement	ASTM C150 (Type I or Type III), or ASTM C595 Type IL. One source for duration of pouring of each product type.
Aggregates	ASTM C33 or C330, non-reactive as determined by ASTM C1778.
Water	Clean and free from deleterious substances.
Bearing Pads	Elastomeric isotropic random oriented fiber reinforced pad; JVI Inc. "Masticord," Voss Engineering "Fiberlast," or equal.
Insulated Panel Accessories	
Extruded Polystyrene (XPS) Rigid Insulation	4-inch thickness, Rigid, unfaced, square edged thermal extruded polystyrene insulation formed from polystyrene base resin conforming to ASTM C578, Type IV.
Type IV	Nominal density of 1.55 lb/ft^3 with minimum thermal resistance (R-value) per 1.0 inch thickness of 5.0 °F-ft^2-h/Btu at 75 °F
Wythe Connectors	
Nonmetallic	Non-conductive, non-corrosive, thermoplastic resin or fiberglass composite type with maximum thermal conductivity of 2.50 Btu-in/(hr-ft^2 °F) per inch of length.

2.3 MANUFACTURER

A. Configuration

1. Members shall be rigid, adequately braced, and free from dents, gouges, or other irregularities which would impair the quality, appearance, or performance of the members.

2. The side edges of cored members shall have a continuous grout key. Side edges shall have a rounded soffit edge unless otherwise approved by Engineer.

B. Release of Tension

1. The concrete shall attain a compressive strength of at least 3,500 psi before the pretension stress in the prestressing strands is released.

C. Embedded Accessories

1. All plates, inserts, and other accessories which are required to be embedded in the members shall be installed at the time of manufacture. All embedded items shall be accurately positioned and shall be rigidly held in position during concrete placement. It is essential that bearing plates be installed in exact and true position.

2. Members shall be provided with lifting loops or similar devices to facilitate handling as needed. No lifting devices shall be placed on a permanently exposed exterior face. Lifting devices placed on permanently exposed interior faces shall be properly recessed and fill with non-shrink grout.

D. Openings and Inserts

1. Openings for doors, louvers, windows, and other items as indicated on the drawings shall be incorporated into the design and fabrication. Openings greater than 6 inches in size shall be incorporated at the time of manufacture. All formed openings shall be accurately positioned and shall be rigidly in position during concrete placement.

2. The drawings shall be carefully reviewed for the openings and inserts required by the work of all trades, and all openings and inserts which are beyond the limitations of field modification shall be provided by the manufacturer. Side edges of openings shall be formed or cut neatly and shall have vertical surfaces. Saddles, headers, or other suitable supports shall be provided by the manufacturer as necessary for the size and location of openings.

3. The manufacturer's submittals shall state the limitations for field cutting or modification.

E. Ends of Strands

1. Protruding ends of prestressing strands shall be cut off flush with the concrete and coated or finished to prevent rusting.

F. Surface Finish

1. The top surface of horizontal members shall be given a smooth float finish unless specifically indicated otherwise on the drawings.

2. Formed surfaces shall have a smooth uniform texture and color. All fins and other projections shall be removed from formed surfaces, and all holes and other surface defects shall be repaired to the satisfaction of Engineer.

G. Shop Markings

1. Each member shall have shop markings, painted or labeled at a place not exposed to view after installation, to indicate location and position in the structure in accordance with the manufacturer's layout drawings.

H. Bearing Pads

1. Bearing pads shall be used where indicated on the drawings or in accordance with the manufacturer's typical connections details as accepted by Engineer.

I. Connections

1. All permanently exposed materials for connections and welds shall be stainless steel including but not limited to connector straps and loose plates. Embedded items such as plates and angles in architectural precast concrete units shall be stainless steel and recessed with a minimum cover of 1-1/2 inches. Embedded connections shall be grouted with non-shrink grout. Connections utilizing embedded items shall account for movement, deflections, and rotation of the connector strap and/or loose plate such that the non-shrink grout is not crushed or cracked.

J. Drip Strips

1. Drip strips located on the exterior wall face shall be cast in the concrete and integral with the forming of the wall panel and shall be provided at the head of all openings for overhead doors and as indicated on the drawings. Field cutting of drips into the exterior face of wall panels shall not be allowed.

K. Opening Reinforcement

1. Architectural precast concrete units shall be transversely reinforced with a minimum of two No. 4 reinforcing bars in each concrete wythe for each orthogonal direction at all openings. Reinforcing bars shall extend a minimum of 24 inches beyond the edges of openings. Where panel edges or other obstruction do no permit the minimum 24 inch extension, reinforcing bars shall be provided with a standard hook.

L. Cover of Reinforcement and Hardware

1. Reinforcement and hardware shall have a minimum cover of 3/4 inch accounting for the depth of architectural features including but not limited to rustification joints and chamfer strips and shall be accurately located.

M. Architectural Precast Minimum Reinforcement

1. For precast and precast/prestressed concrete units, each wythe shall be reinforced in the transverse direction of the architectural concrete unit with structural reinforcing steel or welded wire fabric with a minimum ratio of 0.0020 of the gross concrete cross-section area. Prestressed concrete units shall be required to comply with this minimum reinforcement requirement.

2. For precast and precast/prestressed architectural precast concrete units, each wythe shall be reinforced in the length of the architectural precast concrete unit with structural reinforcing steel or welded wire fabric with a minimum ratio of 0.0018 of the gross concrete cross-section area. Prestressed architectural concrete units shall be required to comply with this minimum reinforcement requirement.

3. Each wythe of architectural precast concrete units shall be transversely reinforced with a minimum of two No. 4 reinforcing bars each end and at each lifting location.

2.4 ARCHITECTURAL FINISHES

A. Exterior Finishes

1. The exterior exposed faces of architectural precast concrete units shall be as indicated on the Drawings.

2. Architectural finishes shall be returned at all edges and openings exposed to view where indicated on the Drawings. Grey cement for architectural finishes shall include samples and mock-ups and shall be submitted for review by the Engineer.

B. Interior Finishes

1. Interior finishes exposed to view shall have an acid etched finish and to be painted by others. All other interior finishes shall be light broom or as cast smooth form finish.

2.5 INSULATED (SANDWICH) ARCHITECTURAL PRECAST UNITS

A. Insulated (Sandwich) Panel Type

1. Insulated precast units shall be composite type composed of exterior and interior concrete wythes with rigid insulation between each wythe.

2. The interior concrete wythe shall be designed to support the exterior wythe during stripping, handling, shipping, and erection. The interior, structural concrete wythe shall be designed to support all permanent structural loadings.

3. Composite action between the interior and exterior concrete wythe for stripping stresses shall be allowed provided the Manufacturer can provide adequate documentation and experience on two previous projects with similar product types and sizes.

4. Concrete solid areas between the exterior and interior concrete wythes shall not be accepted by the Engineer except where indicated on the drawings. Concrete solid areas shall be allowed above the insulated building envelope at parapets where both sides are exposed to weather.

5. Concrete solid areas shall not be allowed at door and window openings unless specifically indicated on the drawings. Insulation shall extend edge to edge. Where nailers are

required, plastic nailers with a bond breaker shall be provided between the two concrete wythes.

B. Wythe Connector Type

1. Wythe connectors shall be nonmetallic, fiberglass type. Wythe connectors allowing thermal bridging through the panel shall be rejected. Partially composite wythe connectors shall not be allowed.

C. Wall Panel Insulating System Value

1. Individual insulated architectural precast units shall have a average R-value of 10.

2.6 CEMENTITOUS MATERIALS FOR ERECTION

A. Grouting of Concrete Joints

1. Joints indicated on the drawing to be grouted shall be grouted with non-shrink grout.

2.7 CURING

A. Concrete shall be cured by continuous surface saturation or inundation, exposure to steam or saturated air in a tightly closed room or chamber, or other method acceptable to Engineer. Moist curing shall be maintained for at least 7 days when Type I cement is used, or 48 hours when Type III cement is used. The steam curing period shall be as needed to reach minimum compressive strength. Members shall be air cured in the fabricator's yard until they attain an age of at least 30 days.

2.8 TOLERANCES

A. Tolerances for prestressed concrete members shall be as recommended by PCI MNL-117, Division VII.

B. Prestressed members will be rejected for any of the following:

1. Length variation in excess of 1/2 inch (1/4 inch each end) of adjacent units or 1 inch maximum between the longest and shortest units.

2. Edges varying in excess of specified tolerance criteria.

3. Deviation from design camber, differential camber between adjacent members of the same design, or warp or camber which cannot be controlled by the fastening system between members.

4. Improperly placed accessories or boxouts.

5. Unsatisfactory surface finish.

6. Exposure of wire mesh, reinforcing steel, or prestressing strand, except where cut off at the ends.

7. Honeycomb.

8. Fractures, cracks, chips, or spalls which cannot be repaired to the satisfaction of Engineer.

9. Irregularities resulting from damaged forms.

10. Misaligned rustification joints and other architectural features.

2.9 TESTING

A. Six concrete compression test cylinders shall be cast each day of concreting operations. An additional set of six cylinders shall be cast each time there is a change in the concrete mixture during the day's operations. Control test specimens shall be tested as necessary to determine when to transfer stress from the temporary end anchorage to the bond in the concrete. At least two cylinders from each set shall be tested at an age of 28 days.

B. Each concrete mixture shall be tested at least once each week, minimum of one test, for water-soluble chloride ion in accordance with ASTM C1218. Maximum water-soluble chloride ion concentrations in prestressed, hardened concrete at an age of 28 days shall not exceed 0.06 percent expressed as a percentage of mass of cement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Installer shall have been regularly engaged for at least three years in the installation of precast structural concrete similar to the requirements of the project. Prestressed concrete members shall be set in position in accordance with the manufacturer's layout and the drawings. Bearing pads shall be installed as indicated on the design and fabrication drawings. Members shall rest solidly upon the supports, without rocking.

B. Temporary Bracing and Supports

1. Precast members shall be temporarily supported during construction. Temporary support bracing, shoring, or other members may anchor into the permanent structure when acceptable to Engineer.

2. Temporary supports shall not be anchored into concrete members in areas where conduit is encased, where the concrete is to be a liquid containing structure, or in any other location where the quality or durability of the permanent construction would be lessened.

3. Anchors for temporary supports shall be a mechanical type and shall be removed when the temporary shoring system is no longer needed. Holes left after anchor removal shall be patched with cementitious mortar.

C. Precast Wall Panels

1. Members in final position shall be loaded as necessary so that adjacent edges are even and grouted between the bottom of the panels and foundation. Grout dams shall be provided at openings and other locations as necessary to prevent leakage. Shims shall be left in place until the grout has attained sufficient strength to withstand the axial loads. All grout that seeps through joints exposed to view shall be removed before it hardens.

2. Member architectural features and finishes shall be acceptable to the Engineer with no discernable defects at a distance of 20 feet from the member.

3. When all members have been placed and anchored to the supports as indicated on the drawings, the joints shall be properly sealed per the specifications.

D. Welding

1. If welded connections are required, welding shall be done by qualified welders possessing valid certificates under the qualification procedures of AWS D1.1. Care shall be exercised to avoid overheating and cracking the concrete adjacent to the anchorage plates. All members damaged during welding shall be removed and replaced by the Installer with new, undamaged members at no additional cost to Owner.

E. Field Cutting

1. Openings less than or equal to 6 inches in size and within the manufacturer's limitations and not requiring cutting of prestressing strands, shall be cut in the field by the erector in accordance with the manufacturer's standard recommendations. Openings requiring cutting of prestressing strands shall be made during manufacture; prestressing strands shall not be cut in the field.

2. All cutting of concrete sections shall be done with suitable concrete saws or core drilling equipment in a manner that will provide smooth, even cut surfaces. Side edges of openings shall have vertical surfaces.

3. All lifting loops shall be cut off flush with the top surface of the member before any covering materials are placed.

F. Joints

1. The surfaces of all members shall present a neat and uniform appearance.

2. The joints that will be permanently exposed to view after the work has been completed shall be caulked. Caulking requirements, and the areas to be caulked, are covered in the Joint Sealants section.

G. Repairs After Erection

1. Surfaces damaged during handling or erection, and areas from which fins and projections have been removed, will be repaired to a uniform finish that will blend in with the rest of the member. All repairs shall be accomplished to the satisfaction of Engineer.

End of Section

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SECTION 03 60 00 – GROUTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers procurement and installation of grout. Unless otherwise specified, only nonshrink grout shall be furnished.

B. Epoxy grouting and adhesive anchoring of anchor bolts, threaded rod anchors, and reinforcing bars is covered in the Anchorage in Concrete and Masonry section. Grouting of masonry is covered in the Masonry section.

1.2 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

Manufacturer’s information for all products and concrete ingredients supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

The intended location for use of each differing grout type.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2.1 MATERIALS

Nonshrink Grout	Precision cementitious grout with demonstrated non-shrinking properties, minimum 28 day compressive strength of 8000 psi; L&M "Crystex,” Sika “SikaGrout 328,” Euclid “Hi-Flow Grout,” Dayton Superior "Sure-Grip High Performance Grout,” or SpecChem “SC Precision Grout.” Grout selected shall be consistent with intended use as stated in manfacturer’s product data sheets. Grout that is used in submerged locations within structures that are part of the treatment process for producing potable water shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600.

Water Clean and free from deleterious substances.

2.2 CEMENTITIOUS GROUT

A. Cementitious grout shall be furnished factory premixed so that only water is added at the jobsite.

2.3 EPOXY GROUT

A. Epoxy grout shall be used in lieu of cementitious grout when required by the equipment manufacturer for performance or warranty requirements. Epoxy grout shall be a three component system consisting of a Part A (resin), Part B (hardener) and Part C (aggregate). All three components shall be products of the same manufacturer and be compatible. Epoxy grout products and installation procedures shall be submitted to Engineer for approval.

PART 3 - EXECUTION

3.1 CEMENTITIOUS GROUT INSTALLATION.

A. Preparation

1. The concrete foundation to receive cementitious grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

B. Mixing

1. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout, nor shall water content exceed the amount recommended by the manufacturer.

C. Temperature Restrictions

1. Grout shall be placed in accordance with the manufacturer's published temperature restrictions. Ambient temperature and grout temperature shall be a minimum of 40 degrees F and rising at time of placement. Grout shall not be placed on frost covered surfaces. Grout shall be protected from freezing until it has reached a minimum strength of 4,000 psi. Grout shall not be placed when the ambient or grout temperature exceeds 90 degrees F.

D. Placement

1. Unless otherwise specified or indicated on the Drawings, grout under baseplates shall be 1-1/2 inches thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled

without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

E. Edge Finishing

1. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

F. Curing

1. Grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

3.2 EPOXY GROUT INSTALLATION

A. Epoxy grout shall be installed in accordance with ACI 351.5.

End of Section

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SECTION 05 50 00 - MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the fabrication and erection of miscellaneous metal items not covered in other sections.

B. The items covered by this section include, but are not limited to, the following:

1. Metal framing and supports for overhead doors.
2. Metal framing and supports for door frames made of structural shapes.
3. Metal framing and supports for mechanical and electrical equipment.
4. Metal shapes used at door sills.
5. Metal shapes used for applications not indicated in other sections.
6. Miscellaneous steel trim.
7. Clevises and Turnbuckles.
8. Eyebolts and Eyenuts.
9. Headed concrete anchors.
10. Deformed bar anchors.
11. Bearing and leveling plates.
12. Metal ladders and fall protection safety systems.
13. Metal floor plate (checkered plate).
14. Stop plates and grooves.

C. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 SUBMITTALS.

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Fabrication, setting, and erection drawings, identifying all bolted and welded connections.

3. For ladders, drawings sealed by a professional engineer registered in the state of the project. Data shall include confirmation that the design meets all applicable code requirements. Calculations shall be submitted when requested by Engineer.

C. Drawings and Data

1. Complete data, fabrication drawings, and setting or erection drawings covering all miscellaneous metal items shall be submitted in accordance with the Submittal Procedures section.

D. Connection and Welding Details

1. All bolted connections and welds shall be properly identified on the shop drawings. Welding procedures, welding procedure qualification records and welder qualifications shall be submitted.

E. Ladder Data and Calculations

1. Submittals for ladders that are designed by the fabricator shall include drawings sealed by a professional engineer registered in the state of the project. Data shall include confirmation that the design meets all applicable code requirements. Calculations shall be submitted when requested by Engineer.

1.3 DELIVERY, STORAGE, AND HANDLING.

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Miscellaneous metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

PART 2 - PRODUCTS

2.1 GENERAL.

A. All miscellaneous metals shall be detailed and fabricated to facilitate installation as indicated on the drawings. All required field connection materials shall be furnished.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Ladders, and their anchors to the supporting structure, shall be designed by a professional engineer registered in the state of the project. The ladder design shall meet the requirements of OSHA Section 1910.23 and ANSI A14.3. The minimum design load for ladders shall be 300 lb per 10 feet of length, but shall not be less than 300 lb. Design of anchorage into concrete or masonry structural elements shall be as indicated in the Anchorage in Concrete and Masonry section. Ladders with climbing heights greater than 24 feet, or where the length of climb is less than 24 feet but the top of the ladder is more than 24 feet above the ground, floor, or roof level, shall be provided with a fall protection safety system as indicated on the Drawings. Ladders with fall protection safety systems shall have the ladder and anchorage designed to resist the associated design level impact forces. Rest platforms shall be provided to limit straight climb lengths to 30 feet.

2.3 MATERIALS.

Steel

Shapes, Plates, and Bars	ASTM A572 Grade 50 or ASTM A992.
Sheets	ASTM A1008 CS Type B or A1011 CS Type B.
Pipe	ASTM A53, Type E or S, Grade B (F_y = 35 ksi).
Round Hollow Structural Sections	ASTM A500, Grade C (F_y = 50 ksi).
Square and Rectangular Hollow Structural Sections	ASTM A500, Grade C (F_y = 50 ksi).
Fasteners	
Bolts, Unfinished	ASTM A307.
Nuts, Heavy-Hex	ASTM A563, grade and finish compatible with bolts.
Washers	Flat, hardened, ASTM F436, Type 1.
Forged Steel Clevises and Turnbuckles	AISI C-1035.
Forged Steel Eyebolts and Eyenuts	AISI C-1030, ANSI B 18.15 Type 2 shoulder pattern unless otherwise required.

Stainless Steel

Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Fasteners	
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts
Washers	Flat, ANSI/ASME B18.22.1, Type 316.
Aluminum	
Sheet and Plate	ASTM B209, Alloy 6061-T6.
Rolled Sections	ASTM B308, Alloy 6061-T6.
Rod and Bar (Rolled or Drawn)	ASTM B211, Alloy 6061-T6 or 2017-T4.
Extrusions	ASTM B221, Alloy 6063-T5 or T6.
Pipe	ASTM B429, Alloy 6061-T6.
Castings	ASTM B26 or B85.
Weld Metal (Steel Connections)	ANSI/AWS D1.1, Table 3.1, filler metal with minimum 70 ksi tensile strength unless otherwise required.
Headed Concrete Anchors	ASTM A108 with a minimum 50,000 psi yield strength and minimum 60,000 psi tensile strength. TRW/Nelson or equal.
Deformed Bar Anchors	ASTM A496 with a minimum 70,000 psi yield strength and minimum 80,000 psi tensile strength. TRW/Nelson division or equal.

Ladders

Steel	Siderails shall be continuous and spaced as indicated on the Drawings. Rungs shall be steel bars, with shape and minimum size as indicated on the Drawings. Ladders, brackets, and fasteners in exterior locations shall be galvanized.
Aluminum	Siderails shall be continuous and spaced as indicated on the Drawings. Rungs shall be extruded aluminum tubes, with shape and minimum size as indicated on the Drawings.
Anchors into Concrete or Masonry Elements	As indicated in the Anchorage in Concrete and Masonry section.
Extending Ladder Safety Post	Bilco Ladder Safety Post or approved equal.
Fall Protection Safety System	OSHA approved system consisting of a carrier, safety sleeve, lanyard, and connectors. The same fall protection system shall be used for all ladders on the project. The system shall be suitable for operation with a body harness. Body harness provided by Owner. Miller Saf-T-Climb with Removable Hatch Dismount or equal.
Fall Protection Safety System Telescoping Anchor Extension	3M Lad-Saf Telescoping Single Point Anchor (SPA) Extension or approved equal.

Floor Plate

Steel	ASTM A786, carbon steel, manufacturer's standard skid resistant pattern.
Stainless Steel	ASTM A793, Type 316L, raised pattern A.
Aluminum	ASTM B632, Type 6061-T6, with raised pattern on one side.
Fasteners	3/8 inch stainless steel slotted flathead machine screws.

Shop Coatings

Universal Primer	As indicated in the Protective Coatings section.

Galvanizing	ASTM A123, A153, A385, and F2329 as applicable.

2.4 FABRICATION.

A. General.

1. Items shall be preassembled in the shop to greatest extent possible. Metals shall be cut, drilled, and punched cleanly and accurately. Sharp or rough edges on exposed surfaces shall be removed.

B. Fasteners.

1. Unless indicated otherwise on the Drawings, stainless steel fasteners shall be used for fastening aluminum or stainless steel, steel fasteners shall be used for fastening steel, and bronze fasteners shall be used for fastening bronze.

C. Bearing and Leveling Plates.

1. Loose bearing and leveling plates for steel items bearing on masonry or concrete shall be hot-dip galvanized.

D. Ladders.

1. Unless otherwise indicated on the Drawings, all ladders provided under this section shall be of the same type and design.

2. Ladders, fall protection safety systems, and rest platforms shall be provided as indicated on the Drawings. Ladder rails intersecting guardrailing shall be configured to provide an aesthetically pleasing transition, although ladder rails need not be physically attached to the guardrailing. There shall be no gaps between ladder rails and adjacent guardrailing that would allow passage of a sphere greater than 4 inches in diameter.

3. Ladders that terminate below an access hatch and do not require a fall protection safety system shall be furnished with extending ladder safety posts.

4. Ladders that terminate below an access hatch and also require a fall protection safety system shall incorporate a telescoping anchor extension that is integral with the safety system. The telescoping anchor system shall replace the requirement for the extending ladder safety post.

E. Metal Floor Plates.

1. Shop welded stiffeners or grating backup shall be provided when indicated on the Drawings. Stiffeners and grating backup shall be of the same material as the floor plate.

2. Warped or bent plates shall be straightened so they will lie perfectly flat.

3. Floor plates shall be secured to supports at 12 inch centers. Connection devices shall not protrude above the plate surface. Floor plate with grating backup shall include access holes to allow access to grating hold-down devices beneath the plate.

4. Floor plates which are indicated to be removable shall be detailed and fabricated in sections which weigh no more than 100 lb . At least one flush bar drop handle shall be included at each end of the removable section.

F. Stop Plates and Grooves.

1. Stop plates shall be fabricated with the edges accurately finished. Plates shall be provided with suitable lifting handles and angle stiffeners as indicated on the Drawings. Each stop plate shall be permanently marked to identify its intended location.

2. Stop plate grooves shall be aluminum Neenah “Series R-7501” with all interior surfaces machined.

G. Basin Weir Plates.

1. Basin weir plates shall be fabricated to dimensions indicated on the Drawings, with top surface cut to shape. The top edge of each weir plate shall be straight within 1/8 inch . Particular care shall be taken in cutting operations. Burrs or irregularities on cut edges shall be removed by grinding. Carbon steel weir plates shall be hot dip galvanized after fabrication.

2.5 SHOP COATING.

A. All miscellaneous metal items shall be shop coated as specified herein, except as otherwise indicated. The requirements for field painting are covered in the Protective Coatings section.

B. Contact surfaces of miscellaneous metals that are to be field welded shall be masked so that no shop primer or galvanizing will be applied in the vicinity of the weld.

C. Cleaning.

1. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter, and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by solvent, high-speed power wire brushing or by blasting to the extent recommended by the shop coating manufacturer.

D. Edge Grinding.

1. Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius as needed to ensure satisfactory shop coating adherence.

E. Galvanizing.

1. Unless otherwise indicated herein or on the Drawings, all steel in exterior locations shall be galvanized. All galvanizing shall be done by the hot-dip process after fabrication. An approved zinc-rich paint shall be used to touch up minor coating damage, in accordance with ASTM A780. Materials with significant coating damage shall be regalvanized or replaced.

2. Bolts, nuts, and washers shall be galvanized when connected materials are galvanized or where indicated on the Drawings. The use of zinc-plated bolts will not be acceptable.

F. Prime Painted Steel.

1. Unless otherwise specified or indicated on the Drawings, all ungalvanized steel shall be given a shop coat of universal primer after fabrication. The dry film thickness of the universal primer shall be at least 5 mils . Steel surfaces shall be coated as soon as practicable after cleaning. Steel shall not be moved or handled until the shop coat is dry and hard.

G. Stainless Steel.

1. Unless otherwise specified, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or a light blast cleaning shall produce a modest etch and remove all embedded iron and heat tint. Surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be retreated as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

H. Aluminum.

1. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of bituminous paint.

I. Castings.

1. Shop coating of miscellaneous iron castings will not be required.

J. Other Surfaces.

1. Painting of zinc coated steel or bronze surfaces will not be required.

PART 3 - EXECUTION

3.1 GENERAL.

A. Miscellaneous metals shall be placed in accurate location, alignment, and elevation. Edges and surfaces shall be free of warps, local deformations, and unauthorized bends. Connections shall be accurately fitted.

B. Field welding or cutting shall not be performed on galvanized or primed surfaces.

3.2 BOLTED CONNECTIONS.

A. Unless otherwise indicated on the Drawings all bolted connections shall be snug tight.

3.3 WELDING.

A. Welds that are exposed to view shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches and shall be spaced not more than 6 inches apart.

B. Surfaces within 2 inches of a weld shall be free from loose or thick scale, slag, rust, moisture, grease, paint and other foreign materials that would prevent proper welding or release objectionable fumes.

C. Deformed bar anchors, headed concrete anchors, and shear connectors shall be welded with an automatic stud welding gun per the manufacturer's recommendation. Hand welding will not be acceptable.

3.4 BEARING AND LEVELING PLATES.

A. Bearing and leveling plates shall have the bottom surfaces cleaned prior to installation. Plates shall be set on wedges or leveling nuts, and after positioning and leveling, anchor bolts shall be tightened. Grout shall be placed solidly below plates with no remaining voids.

3.5 STOP PLATES AND GROOVES.

A. Stop plate grooves shall be installed plumb and straight within a tolerance of 3/32 inch and with the opposite sides and bottom aligned in a single plane to prevent binding of the stop plate. If necessary to meet this requirement, a space shall be boxed out for guides, and the guides grouted in place later. Stop plates shall be set in place as needed for testing and startup procedures.

3.6 BASIN WEIR PLATES.

A. Before installation, surfaces in contact with concrete shall be given a heavy coating of sealant as specified in the Caulking section. Weir plates shall be adjusted after installation to provide uniform overflow rate at all points.

End of Section

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SECTION 05 50 13 - STRUCTURAL METALS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the fabrication and erection of structural metal items.

B. Except as otherwise specified or indicated on the Drawings, all work shall conform to the applicable provisions of the AISC “Steel Construction Manual” (15th edition) with the exception of the “Code of Standard Practice for Steel Buildings and Bridges”; and the Aluminum Association “Specification for Aluminum Structures.”

C. Special inspection during the fabrication and erection of structural steel, if required by the local building code, is addressed in the Code-Required Special Inspections and Procedures section.

D. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports. Mill certification reports for record only for each type of structural steel and requiring charpy V notch test results.

2. Fabrication, setting, and erection drawings, identifying all bolted and welded connections. Submit stamped erection sequencing plan, erection temporary bracing, shoring, and procedures for record.

3. Welding procedures, welding procedure qualification records, and welder qualifications.

4. For delegated design items:

   a. Drawings shall be sealed by a professional engineer registered in the state of the project.
   b. Drawings shall include all loading and design criteria indicated in the “Construction Documents” section of the applicable building code.
   c. Drawings shall indicate whether the members and connections have been designed and detailed for seismic resistance.
   d. Calculations shall be submitted when requested by Engineer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Structural metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

B. Bolting materials shall be stored indoors. Weld rod shall be stored in accordance with the supplier's instructions and AWS D1.1.

1.4 FABRICATOR QUALIFICATION

A. All fabricating plants providing structural steel shall be qualified fabricators who participate in the AISC Certification program and are designated an AISC Certified Plant, Category BU.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials needed for both shop and field assembly shall be furnished.

2.2 MATERIALS

Steel

Shapes (W, WT, C, MC)	ASTM A992.
Shapes (S, M, HP)	ASTM A572 Grade 50.
Other Shapes (angles)	ASTM A572 Grade 50.
Plates and Bars	ASTM A572 Grade 50.
Sheets	ASTM A1008 CS Type B or A1011 CS Type B.
Pipe	ASTM A53, Type E or S, Grade B (F_y = 35 ksi).
Round Hollow Structural Sections	ASTM A500 Grade C (F_y = 50 ksi), or ASTM 1085 Grade A (F_y = 50 ksi).
Square and Rectangular Hollow Structural Sections	ASTM A500 Grade C (F_y = 50 ksi), or ASTM 1085 Grade A (F_y = 50 ksi).
Bolts and Nuts	
Bolts, High Strength	ASTM F3125, Grade A325.
Bolts, unfinished	ASTM A307.
Nuts, Heavy-Hex	ASTM A563, grade and finish compatible with bolts.

Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436.
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator; type compatible with bolts tested in accordance with Article 10.2 of ASTM F959.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A36. Threaded rods shall have sufficient threading to permit the maximum adjustment available. Continuously threaded rod is not acceptable for rods over 12 inches in length.
Forged Steel Sleeve Nuts	AISI C-1018, Grade 2.
Stainless Steel	
Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI/ASME B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Aluminum	
Sheet and Plate	ASTM B209, Alloy 6061-T6.
Rolled Sections	ASTM B308, Alloy 6061-T6. All members shall be Aluminum Association standard shapes. Special shapes with sloping flange surfaces, or Army-Navy type members, shall not be used unless specifically indicated on the Drawings.

Rod and Bar (Rolled or Drawn)	ASTM B211, Alloy 6061-T6 or 2017-T4.
Extrusions	ASTM B221, Alloy 6063-T5 or T6.
Pipe	ASTM B429, Alloy 6061-T6.
Rivets	ASTM B316, Alloy 6061-T6.
Bolts, Aluminum	ASTM F468, Alloy 2024-T4.
Nuts, Aluminum	ASTM F467, Alloy 6061-T6.
Washers, Aluminum	
Flat	ANSI/ASME B18.22.1, Type 6061 T-6.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 6061-T6.
Weld Metal (Steel Connections)	ANSI/AWS D1.1, Table 3.1, filler metal with minimum 70 ksi tensile strength unless otherwise required.
Shop Coatings	
Universal Primer	As indicated in the Protective Coatings section.
Bituminous Paint	Metal fabricator's standard product.
Galvanizing	ASTM A123, A153, A385, and F2329 as applicable.

2.3 STRUCTURAL STEEL BOLTED CONNECTIONS

A. Bolt holes shall have a diameter nominally 1/16 inch larger than the nominal bolt diameter. Bolt holes for one ply of vertical diagonal bracing connections may be oversized to a diameter nominally 3/16 inch larger than the nominal bolt diameter.

2.4 SHOP COATING

A. All items shall be shop coated as specified herein. The requirements for field painting are covered in the Protective Coatings section.

B. Contact surfaces of structural steel slip critical bolted connections shall not be shop coated. Contact surfaces of structural steel bearing type bolted connections may be shop coated.

C. Cleaning

1. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter, and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by solvent, high-speed power wire brushing or by blasting to the extent recommended by the paint manufacturer and as required in the Protective Coatings section.

D. Edge Grinding

1. Sharp projections of cut or sheared edges of ferrous metals which will be submerged in operation, except for items specified to be hot-dip galvanized, shall be ground to a radius as needed to ensure satisfactory paint adherence and as required in the Protective Coatings section.

E. Prime Painted Steel

1. Unless otherwise specified or indicated on the Drawings, all ungalvanized steel shall be given a shop coat of universal primer after fabrication. The dry film thickness of the universal primer shall be at least 5 mils. Steel surfaces shall be prime coated as soon as practicable after cleaning. Steel shall not be moved or handled until the shop coat is dry and hard.

F. Galvanizing

1. Steel materials required to be galvanized are indicated on the Drawings. All galvanizing shall be done by the hot-dip process after fabrication. An approved zinc-rich paint shall be used to touch up minor coating damage, in accordance with ASTM A780. Materials with significant coating damage shall be regalvanized or replaced.

2. Bolts, nuts, and washers shall be galvanized when connected materials are galvanized or where indicated on the Drawings. The use of zinc-plated bolts will not be acceptable.

G. Stainless Steel

1. Unless otherwise specified, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or a light blast cleaning shall produce a modest etch and remove all embedded iron and heat tint. Surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be retreated as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

H. Aluminum

1. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of bituminous paint.

PART 3 - EXECUTION

3.1 STRUCTURAL STEEL ERECTION

A. Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevations of the top of floor and roof members shall be within 1/16 inch of the elevations indicated on the Drawings. The faces of girts and other

supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch.

B. All members and parts, as erected, shall be free of warps, local deformations, and unauthorized bends. All parts shall be assembled accurately as indicated on the Drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills and only with the approval of Engineer. Enlarging holes by burning will not be permitted.

C. Baseplates shall be set level in exact position and grouted in place.

D. Inspection and Testing

1. Special inspection will be performed as indicated in the Code Required Special Inspections and Procedures section. The erector shall provide access as needed to facilitate all inspections and shall provide timely notification during erection when inspection milestones are approaching.

3.2 STRUCTURAL STEEL BOLTED CONNECTIONS

A. Unless otherwise indicated on the Drawings, bolted connections for structural steel, as defined in the AISC manual, shall be made with ASTM F3125 high strength bolts conforming to the "Specification for Structural Joints Using High-Strength Bolts" as approved by the Research Council on Structural Connections. The method of installation, pretensioning procedures, bolting equipment and tools shall likewise conform to the above referenced standard.

B. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of loose mill scale, dirt, burrs, oil, and other foreign material that would prevent solid seating of the parts.

C. Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Bolt length shall be increased as needed to accommodate the beveled washers.

D. Tightening of each connection assembly shall progress systematically from the most rigid part of the joint toward the free edges until all have been sufficiently rotated or the load indicator washers on all bolts have been closed to the average gap stipulated by the load indicator washer manufacturer.

E. Except as otherwise indicated on the Drawings or specified herein, bolted connections shall be bearing type with threads excluded from the shear plane. Slip critical connections shall be used in diagonal bracing connections, where oversize holes or slotted holes parallel to the direction of the load are used, and where indicated on the Drawings.

F. Bolts in all structural steel connections, both bearing and slip critical, shall be fully pretensioned in accordance with the AISC standards unless specifically noted otherwise on the Drawings.

The calibrated wrench method of pretensioning bolts will not be acceptable. Acceptable pretensioning methods are as follows:

Connection Type	Acceptable Pretensioning Method
Bearing	Turn of the nut method and load-indicator washers are acceptable. Tension control (twist-off) type bolts shall not be used.
Slip-Critical	Load indicator washers.

G. Turn of the Nut Method

1. The bolt, nut, and material shall be match marked. A wax lumber marker or paint shall be used to clearly mark the assembly.

H. Load-Indicator Washers

1. Load indicator washers shall be installed in accordance with the manufacturer's recommendations, as supplemented herein. To facilitate proper tightening of fastener assemblies with load indicator washers, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the load indicator washer protrusions, in all cases. Whenever possible, the load indicator washer shall be installed on the head end of the bolt. If the bolt head will not be visible for inspection of the indicator washer after installation, or if the bolt head must be turned to tighten the assembly, the load indicator washer may be installed on the nut end of the bolt.

3.3 STRUCTURAL AND STAINLESS STEEL WELDING

A. Welding and related operations shall conform to applicable provisions of AWS D1.1 for steel and AWS D1.6 for stainless steel. All welding shall be performed in accordance with written procedures, using only those joint details which have prequalified status. All welding shall be performed by welders qualified in accordance with the American Welding Society.

B. Welds not dimensioned on the Drawings shall be sized to develop the full strength of the least strength component of the connection.

C. All butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches and shall be spaced not more than 6 inches apart.

D. Surfaces within 2 inches of a weld shall be free from loose or thick scale, slag, rust, moisture, grease, paint and other foreign materials that would prevent proper welding or release objectionable fumes.

E. Only shielded metal arc, gas metal arc, flux cored arc, submerged arc, and gas tungsten arc welding are permitted. For flux cored arc welding, only E70xx one (1) or five (5) wire electrodes with supplemental gas shielding shall be permitted. Use of electroslag or electrogas

welding processes or the short-circuiting transfer mode of the gas metal arc process will not be acceptable.

F. Field welded connections shall not be substituted for field bolted connections indicated on the Drawings.

3.4 STRUCTURAL ALUMINUM

A. Unless otherwise noted, all work shall conform to applicable provisions of the Aluminum Association “Specification for Aluminum Structures.”

B. Connections

1. Connections not specifically detailed on the Drawings shall develop the full strength of the least strength member of the connections. Bolted connections shall be all-bolted bearing type, equipped with a helical spring lock washer under the stationary element (bolt head or nut) and a flat washer under the turned element. All bolts shall be fully tightened. Bolts and nuts for structural aluminum connections shall be stainless steel. A sufficient number of bolts shall be provided in each connection to develop the shear strength of the member.

2. Welded connections shall be made in accordance with the American Welding Society D1.2, Structural Welding Code - Aluminum. All welding shall be performed by welders qualified in accordance with American Welding Society. Welds shall be free of porosity, cracks, holes, and flux. Welded connections shall not be substituted for bolted connections without prior approval of Engineer.

C. Erection

1. Structural aluminum shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevation of horizontal members shall be within 1/16 inch of the elevation indicated on the Drawings.

End of Section

SECTION 05 52 13 - METAL RAILINGS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the design, fabrication, and installation of handrailing and guardrailing fabricated from metal. FRP railing systems, concrete and masonry anchorage, structural metals, and miscellaneous metal fabrications are covered in other sections.

1.2 GENERAL.

A. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.3 SUBMITTALS.

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer's information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Detailed fabrication drawings, sealed by an engineer registered in the state of the project. Each separate piece shall be marked.

3. Setting or erection drawings. Each separate piece shall be marked.

4. Structural calculations, when requested by Engineer.

5. Samples of finishes, when requested by Engineer.

6. Samples of each type of fitting, when requested by Engineer.

7. Color charts showing the full range of colors, when applicable and when requested by Engineer.

PART 2 - PRODUCTS

2.1 GENERAL.

A. Railing systems shall be designed and fabricated by companies normally engaged in the manufacture of such systems. Railing products shall be from a single supplier and the installed systems shall have a uniform appearance throughout the project.

B. At Contractor's option, handrailing and guardrailing shall be either shop fabricated welded systems or prefabricated nonwelded systems designed for field assembly. Welded railing systems shall be fabricated from pipe and accessories by metal fabricators experienced in designing and fabricating welded railing.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Railing System Design Criteria.

1. All railing systems shall be designed and fabricated in compliance with the most stringent requirements of the applicable local building code, OSHA 29 CFR Part 1910, and all other pertinent OSHA regulations and local safety regulations.

2. In case of conflicting requirements, the more stringent requirements shall be applicable.

3. At a minimum, guardrailing and handrailing shall be designed to withstand a uniform load of 50 lb per ft applied in any direction at the top, and a concentrated load of 300 lb applied in any direction at any point along the top. The uniform load and the concentrated load need not be assumed to act concurrently. The design load shall be transferred through the entire railing system and its attachment to the structure.

4. Intermediate rails, including balusters on picket-type systems, shall be designed to withstand a horizontally applied normal load of 50 lb on an area not to exceed 12 inches by 12 inches including openings and space between rails. The load shall be located so as to produce the maximum effects. Reactions due to this loading are not required to be superimposed with the loads specified for the top rail and handrail.

5. An allowable stress increase of 1/3 shall not be incorporated into the design of any part of the railing system.

6. Maximum spacing for railing posts shall be 6 ft.

B. Aluminum Rails.

1. Handrails and guardrails shall be fabricated from 1-1/2 inch ID aluminum pipe. Pickets shall be fabricated from 3/4 inch ID aluminum pipe.

C. Kickplate.

1. Kickplates shall be four inches high and shall be fabricated from similar materials as the railing. Kickplates shall clear the walking surface by 1/4 inch.

D. Fasteners.

1. Unless noted otherwise, all fasteners shall be stainless steel. Where galvanized bolts are indicated on the Drawings or specified, the use of zinc-plated bolts will not be acceptable. Railings shall be fastened to fittings with through bolts or flush set screws; glued or pop riveted connections are not permitted. Fastener details shall be indicated on the submittal drawings.

E. Guarding of Openings.

1. Openings in railing shall be guarded by self-closing gates in accordance with OSHA 1910.29.

F. Expansion Control.

1. Guardrailing in outdoor locations shall have slip joints at least every 60 ft and at all concrete expansion joints to permit expansion and contraction. The gap at each slip joint shall be not less than 1/4 inch.

G. Mounting to Structure.

1. Railing systems shall be mounted to structures as indicated on the Drawings. Design of anchorage into concrete or masonry structural elements shall be as indicated in the Anchorage in Concrete and Masonry section.

2.3 ACCEPTABLE MANUFACTURERS.

A. Metal railing shall be by Julius Blum & Co Inc, Thompson Fabricating, Kee Safety, or approved equal.

2.4 MATERIALS.

Aluminum Systems

Pipe	ASTM B429, Alloy 6005 T-5, Schedule 40 minimum thickness.
Plates	ASTM B209, Alloy 6061-T6.
Fittings, Welded	Angles, offsets, tees, ells, crosses, caps for aluminum, ASTM B429, Alloy 6005-T5, Schedule 40 minimum thickness.

Fittings, Non-welded	Manufacturer's standard component fittings, extruded sections, ASTM B221, Alloy 6005-T5.
Assembly Bolts, Nuts, Washers, and Fasteners	Stainless steel.
Gates	Intrepid “Universal Double-Bar Safety Gate”, Kee Safety “Kee Gate” or approved equal. Galvanized steel. Spring loaded hinge to keep the gate firmly in the closed position when not in use. A mechanical closure device shall be included.
Steel Pipe Sleeves	
Outer Sleeves	Black steel pipe, Schedule 40. Hot-dip galvanized after fabrication.
Removable Post Inner Sleeves	PVC tube, Schedule 40.
Plastic Pipe Sleeves	PVC tube, Schedule 40.
Post Setting Cement	Minwax "Super Por-Rok Cement" or Master Builders Solutions "MasterEmaco T 545".
Anchorage to Prime Painted Steel	High-strength bolts, nuts, and washers in accordance with the Structural Metals section.
Anchorage to Concrete or Masonry	Stainless steel adhesive or expansion anchors in accordance with the Anchorage in Concrete and Masonry section.
Shop Coatings	
Universal Primer	Ameron "Amercoat 385 Epoxy", Carboline "Rustbond", or Tnemec "Series 27 F.C. Typoxy."
Epoxy Enamel	Gray; Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Anodic Finish	AA-M10C22A41, clear unless otherwise required.
Galvanizing	ASTM A123, A153, A385.

2.5 FABRICATION.

A. Unless otherwise indicated on the Drawings, all railings provided under this section shall be of the same type and design.

B. Welded Metal Railings.

1. All angles, offsets, or other changes in alignment in welded pipe railings shall be made with railing ells and welded connectors. Welded joints shall be flush type. Railings shall be smooth, with all projecting joints and sharp corners ground smooth. Members shall be neatly coped and continuously welded or mechanically connected at all junctions. Top rails shall run continuously over posts. All rails and posts shall be in the same plane and shall not be offset. All welding shall be done neatly and substantially by a process (e.g., TIG or MIG) producing a smooth weld. All weld spatter and burrs shall be removed, and all welds shall be thoroughly brushed with a stainless steel power wire brush.

2. Field joints shall be made with a splice-lock connector which shall provide a firm, permanent connection. The connector shall mechanically draw the railing sections together to form tight, hairline joint.

C. Guarding of Openings.

1. Openings in railing shall be guarded by gates.

D. Sleeves.

1. Sleeves for fixed handrail posts shall be fabricated from Schedule 40 PVC pipe or from Schedule 40 black steel pipe hot-dip galvanized after fabrication. Sleeves shall provide at least 1/4 inch clearance all around each post and shall be 5 inches long unless otherwise indicated on the Drawings.

2. Sleeves for removable posts shall have an outer and inner sleeve. The outer sleeve shall be fabricated from Schedule 40 black steel pipe and shall be hot-dip galvanized after fabrication. The inner sleeve shall be Schedule 40 PVC pipe.

2.6 COATING.

A. Aluminum.

1. All surfaces of aluminum which will be in contact with concrete shall be coated with bituminous paint. All surfaces of aluminum which will be in contact with dissimilar metals shall have a 15 mil thick sheet of oriented polyester film placed between the two surfaces.

2. All aluminum railings shall be provided with a clear anodic finish.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. When railings are assembled, all posts shall be plumb and longitudinal members shall be parallel with each other and with the floor surface or slope of stairs. In any section or run of railing, the center lines of all members shall be in true alignment, positioned in the same vertical plane. All posts in fixed handrail sections shall be rigidly attached to the supporting structure. After installation, railings shall be checked for final alignment, using a tightly drawn wire for reference. The maximum misalignment tolerance for railings shall be 1/8 inch in 12 ft. Bent, deformed, or otherwise damaged installations shall be replaced.

B. Attachment to Concrete.

1. Posts shall be attached to concrete structures as indicated on the Drawings. Base flanges and side-mount brackets shall be installed with minimal disturbance to the reinforcing steel.

2. Sleeves shall be rigidly supported in accurate alignment in the forms and shall be positioned vertically so that the top of each sleeve is approximately 1/2 inch below the finished concrete surface. The position of all sleeves shall be carefully measured before railings are fabricated. When the railing is set, the posts shall be wedged in accurate alignment, and the annular space between the posts and sleeves shall be filled with post setting cement to the top of the steel sleeve. Filling of the remaining space with sealant, as indicated on the Drawings, is covered in the Caulking section.

C. Attachment to Steel or Aluminum.

1. Attachments to steel or aluminum shapes shall be made with flanges or with other special attachments or anchorages as detailed on the Drawings.

D. Connections.

1. Welding connectors and splice locks shall be installed in accordance with the manufacturer's recommendations. Other methods of making connections and changes in alignment will be considered, provided complete information covering the proposed method is submitted to Engineer for review

E. Gates.

1. Gates shall be installed in accordance with the manufacturer’s instructions. Alignment and positioning of the gate and surrounding railing system shall be accurate to permit each gate’s self-closing mechanism and closure device to operate as intended without the need for any parts to be field bent or otherwise altered.

End of Section

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SECTION 05 53 13 - METAL GRATINGS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the fabrication and installation of metal grating.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; values expressed in inch-pound units shall govern.

1.2 GENERAL.

A. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.3 SUBMITTALS.

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Detailed fabrication and erection drawings, indicating location of grating supports, profiles, thicknesses, piece lengths and widths, markings of panels, and fastening methods.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Design Criteria.

1. Except as modified herein, the manufacture and fabrication of metal grating shall comply with NAAMM MBG 531 "Metal Bar Grating Manual", and NAAMM MBG 532 “Heavy-Duty Metal Bar Grating Manual”. Grating depth shall be as indicated on the Drawings.

B. Aluminum Grating.

1. Aluminum grating shall be the pressure locked type, with cross bars deformed or swaged to prevent turning. Bearing bars shall be at least 3/16 inch thick flat stock or equivalent I-bars, with center-to-center spacing of 1 3/16 inches . Cross bar center-to-center spacing shall be 4 inches . Grating shall have a mill finish.

2.2 MATERIALS.

Aluminum Grating	ASTM B221, 6061-T6 or 6063-T6 for bearing bars. ASTM B221, 6061-T1 for cross bars.
Grating Fasteners	
Clip Type	Fastened to supporting member with a threaded stud or a power-actuated nail. All components shall be of AISI Type 316 stainless steel.
Anchor Block Type	Block material to match the grating, fastened to supporting member with a threaded stud.
Stepped Type	Non-penetrating, non-welded mechanical fasteners, with stainless steel clips and bolts, and a galvanized cast iron body.
Clips, Bolts, Nuts, Washers	Manufacturer’s standard, AISI Type 316 stainless steel.
Welded Threaded Steel Studs	ASTM A108 fully threaded studs automatically welded with compatible nuts and washers; TRW Nelson Type CFL or equal.
Stepped Locking Fasteners	Non-penetrating, non-welded mechanical fasteners, with stainless steel clips and bolts, galvanized cast iron body; Lindapter “Grate-Fast” or Grating Specialty Co. “G-Clip”.

2.3 FABRICATION.

A. Grating shall be fabricated in panels that can be easily handled by plant personnel. Unless otherwise indicated on the Drawings, the weight of individual panels shall not exceed 150 lbs . Cross bars and edge bars of adjacent panels shall align. After

installation, there shall be not more than 1/4 inch clearance between panels. All bearing bars shall be parallel. Bands and toeplates shall align within 1/8 inch tolerance, vertical and horizontal.

B. Angular, circular, and re-entrant cuts in steel grating may be made by flame cutting. All other cuts in steel grating shall be sawed or sheared. Cuts shall be clean and smooth, without fins, beads, or other projections. Any damaged protective coating shall be fully restored.

C. All cuts in aluminum grating shall be sawed or sheared.

D. Grating panels shall be arranged so that openings are centered on a joint between panels. Toeplates extending the full depth of the grating and four inches above the top shall be provided around openings. Toeplates shall be welded to each bearing bar. The ends of bearing bars need not be banded unless required by the Drawings. Bands shall be welded to the first, the last, and every fourth intermediate bar. Bands and toeplates shall be 3/16 inch thick. Crossbars shall be cut off flush with the outside face of side bars.

E. Steel frames anchored to or cast in concrete to support grating shall be stainless steel or hot-dip galvanized after fabrication.

2.4 SHOP COATING.

A. Finish painting of grating, if required, is covered in the Protective Coatings section.

B. Galvanizing.

1. All galvanizing shall be done by the hot-dip process after fabrication, in conformity with the requirements of ASTM A123, A153, and A385.

C. Aluminum.

1. All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a coat of bituminous paint.

PART 3 - EXECUTION

3.1 GENERAL.

A. All grating shall lie flat, with no tendency to rock when installed. Poorly fitting or damaged grating shall be rejected. Grating openings may be field cut with the approval of Engineer, provided that no more than four consecutive bearing bars are cut. If the grating is cut or modified in the field, affected surfaces shall be repaired or sealed to assure restoration of the corrosion resistance of the grating. Field cut openings must be

spaced so that there are at least as many continuous bars between each opening as there are cut bars at the opening.

3.2 ATTACHMENTS TO SUPPORTING STRUCTURE.

A. All grating supported on steel or aluminum structures shall be attached. Grating shall be attached to the supporting structure in accordance with the grating manufacturer's recommendations. Single span grating over openings in concrete may rest unattached in recesses constructed for that purpose.

B. Fastener Type.

1. Unless otherwise indicated on the Drawings, fasteners may be clip, anchor block, or stepped type. Clip fasteners shall be secured to the supporting structural members with power-actuated nails or with threaded studs in drilled holes.

C. Fastener Types in Corrosive Exposures.

1. For the following areas, only stepped locking fasteners shall be permitted for fastening grating to the supporting structural members.

a. Chlorine Contact Basin
b. Junction Structure

3.3 FINISH TOUCHUP.

A. After erection, all grating shall be cleaned. Damaged coatings shall be touched up in accordance with the grating manufacturer's recommendations to fully restore the corrosion resistance of the grating.

End of Section

SECTION 05 81 00 - ANCHORAGE IN CONCRETE AND MASONRY

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts and anchor rods, adhesive anchors for both threaded rods and reinforcing bars, expansion anchors, screw anchors, and undercut anchors.

1.2 GENERAL

A. Anchors Designed by Engineer

1. Cast-in-place and post-installed anchors that are fully detailed on the Drawings have been designed by Engineer, unless noted otherwise.

2. Anchors detailed on the Drawings as cast-in-place shall not be changed to a post-installed type without approval of Engineer.

3. Post-installed anchors identified on the Drawings as a specific manufacturer and product shall not be changed to a different post-installed manufacturer or product without approval of Engineer.

4. Post-installed anchors identified on the Drawings as a specific anchor type, but indicating no specific product, may use any of the listed products of that anchor type.

5. Contractor shall reimburse Engineer, through Owner, for Engineer’s design costs related to evaluating alternative anchor types, products, or details.

B. Anchors Designed by Contractor or Contractor’s Suppliers

1. Contractor or Contractor’s material suppliers shall be responsible for design of anchors for delegated design items such as railings, ladders, equipment, pipe supports, pre-engineered structures, and other manufactured items, as indicated in the Drawings and Specifications.

2. Cast-in-place anchors shall be used unless post-installed types are indicated on the Drawings or accepted by Engineer.

3. Adhesive anchors used in vibrating applications shall only be used if the anchor manufacturer submits documentation indicating that the product is suitable for the anticipated service conditions.

4. Anchors shall be designed for loads due to all operating conditions, plus relevant snow, wind, and seismic loadings as indicated in the Meteorological and Seismic Design Criteria section.

5. Seismic anchorage design for non-structural components shall include the overstrength factors indicated in ASCE 7, Tables 13.5-1 and 13.6-1, when applicable.

6. Design of anchorage into concrete shall be in accordance with ACI 318 Chapter 17, shall consider concrete to be cracked, and shall not include the strengthening effects of supplementary reinforcement or anchor reinforcement unless approved by Engineer.

7. Design of anchorage into masonry shall be in accordance with TMS 402.

8. Post installed anchors shall be designed in accordance with the anchor manufacturer's research report, and shall consider the applicable effects of anchor spacing, edge distances, embedment depths, and temperature.

9. Anchorage calculations performed by Contractor's suppliers shall utilize design tools applicable to the specific anchorage products intended to be used by Contractor.

C. Materials

1. Unless otherwise indicated, anchors of structural steel members connected to concrete shall have a diameter of at least 3/4 inch, and structural members connected to masonry shall have a diameter of at least 5/8 inch. Anchors for ladders and equipment shall have a diameter of at least 1/2 inch. Anchors for pedestrian railing systems shall have a diameter of at least 3/8 inch.

2. Unless otherwise indicated on the Drawings, anchors used in the following locations and applications shall be of the indicated materials.

Cast-In-Place Anchor Bolts and Anchor Rods	
Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Galvanized steel.
Other exterior locations	Galvanized steel.
Interior locations not subject to corrosion	Carbon steel.
Adhesive, Expansion, Screw, and Undercut Anchors	
Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Stainless steel.
Other exterior locations	Stainless steel.

Interior locations not subject to corrosion	Carbon steel.

1.3 SUBMITTALS

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer's information for all products supplied under this section, in the form of manufacturer's research reports (from independent organizations such as ICC-ES or IAPMO UES), technical data sheets, and certificates of compliance.

2. Shop drawings for anchor bolts, anchor rods, and post-installed anchors, including anchor manufacturer, products, and embedment depth. Shop drawings for anchors designed by Contractor's suppliers shall be sealed by a professional engineer licensed in the state of the project.

3. Anchorage calculations performed by Contractor's suppliers. Calculations shall be prepared and sealed by a professional engineer licensed in the state of the project.

4. Post placement anchor rod survey to confirm conformance with Drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent damage or corrosion. Damaged materials shall be promptly replaced. Materials shall be shipped and stored in original manufacturer's packaging.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated on the drawings, materials shall be as indicated below.

Cast-In-Place Anchor Bolts and Anchor Rods

Carbon steel	ASTM F1554, Grade 36 with compatible nuts.
Galvanized steel	ASTM F1554, Grade 36 with compatible nuts; hot-dip galvanized, ASTM F2329.
Stainless steel	Bolts, ASTM F593, Alloy Group 1 or 2 (minimum yield strength of 45 ksi); nuts, ASTM F594, Alloy Group 1 or 2.
Flat Washers	ANSI B18.22.1; of the same material as anchor bolts and nuts.

Expansion Anchors in Concrete	Products shall be single component anchors tested in accordance with ICC AC193 and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Stainless Steel	Hilti "Kwik-Bolt TZ2 SS304", Hilti "Kwik-Bolt TZ2 SS316", Simpson "Strong-Bolt 2", DeWalt "Power-Stud+SD4", or DeWalt "Power-Stud+SD6".
Screw Anchors in Concrete	Products shall be single component anchors tested in accordance with ICC AC193 and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Stainless Steel	Hilti "KH-EZ" or Simpson "Titen HD".
Undercut Anchors in Concrete	Products shall be tested in accordance with ICC AC193 and shall have a manufacturer's research report in compliance with the applicable building code.
Carbon Steel	Hilti "HDA Undercut Anchor", Simpson "TCA Undercut Anchor", or DeWalt "CCU+ Undercut Anchor".
Stainless Steel	Hilti "HDA-R Undercut Anchor".
Adhesive Anchors in Concrete	Products shall be tested in accordance with ICC AC308, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593, CW.
Reinforcing Bars	ASTM A615, Grade 60, deformed.
Reinforcing Bars, weldable	ASTM A706, Grade 60, deformed.
Adhesive (Epoxy)	Hilti "HIT-RE 500 V3," Simpson "SET-3G", or DeWalt "Pure 110+."
Adhesive (Acrylic)	Hilti "HIT-HY 200 V3", Simpson "AT-3G", or DeWalt "AC200+".

2.2 ANCHORS

A. Cast-in-Place Anchor Bolts and Anchor Rods

1. Cast-in-place anchor bolts and anchor rods shall have forged heads or embedded nuts and washers. Anchors shall be delivered in time to permit setting prior to the placing of structural concrete or masonry grout. Anchor sleeves shall not be used unless acceptable to Engineer. Unless installed in sleeves, anchor bolts and anchor rods shall be provided

with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two nuts, a jam nut, and a washer shall be furnished for cast-in-place anchor bolts and anchor rods indicated on the Drawings to have locknuts; two nuts and a washer shall be furnished for cast-in-place anchor bolts and anchor rods without locknuts.

B. Adhesive, Expansion, Screw, and Undercut Anchors

1. Unless otherwise noted, single nuts and washers shall be provided with adhesive anchors, expansion anchors, screw anchors, and undercut anchors. Adhesive anchors shall be free of coatings that would weaken the bond with the adhesive.

2. Adhesive anchors in hollow CMU masonry and unreinforced brick masonry shall utilize screen tubes as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before tightening of the nuts.

B. Compliance with Manufacturer's Instructions

1. Post-installed anchors shall be installed in accordance with the manufacturer's printed installation instructions and all applicable requirements of the manufacturer's research report for the specific anchor system. If conflicts are found between the Drawings, the manufacturer's printed installation instructions, and the manufacturer's research report installation requirements, Contractor shall notify Engineer for resolution.

C. Special Inspection

1. Special inspection requirements for cast-in-place and post-installed anchors shall be as indicated in the Code-Required Special Inspections and Procedures section. Anchorage work shall be performed in a manner that allows the inspections to take place without adversely impacting the schedule.

3.2 CAST-IN-PLACE ANCHOR BOLTS AND ANCHOR RODS

A. Cast-in-place anchor bolts and anchor rods shall be carefully positioned with templates and secured in the forms prior to placing concrete, or in masonry bond beams prior to placing grout. Contractor shall verify that anchorage devices are positioned in accordance with the Drawings and with applicable equipment or structure submittal drawings.

B. Threads, bolts, and nuts spattered with concrete or masonry grout during placement shall be cleaned prior to final installation of the bolts and nuts.

C. Sleeves shall be filled with non-shrink grout.

3.3 ADHESIVE ANCHORS

A. Adhesive shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

B. Anchors or bars shall be installed in holes hammer drilled into hardened concrete or masonry. Drill shall be set to rotation-only mode when drilling into hollow CMU or into brick. Diameter of holes shall be 1/16 inch larger than the outside diameter of the rod or bar unless recommended otherwise by the anchor system manufacturer. Holes shall be prepared by removing all dust and debris using procedures recommended by the adhesive manufacturer.

C. Adhesive anchors and holes shall be clean, dry, and free of grease and other foreign matter at the time of installation. The adhesive shall be placed and the rods or bars shall be set in accordance with the recommendations of the manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids.

D. Concrete Installation

1. Unless indicated otherwise on the Drawings, reinforcing bars shall be embedded to a depth of 15 bar diameters, and threaded rods shall be embedded to a depth that will develop the yield strength of the rod.

2. Adhesive anchors in concrete shall be installed under the following conditions.

Minimum Age of Concrete Prior to Anchor Installation	21 days.
Concrete Temperature Range	Maximum short-term temperature 162° F, maximum long-term temperature 110° F.
Moisture Condition	Dry concrete.
Type of Lightweight Concrete	N/A
Hole Drilling and Preparation	Hammer drill only.

3. Installation of adhesive anchors into concrete that are either horizontal or upwardly inclined shall be performed only by personnel certified by the ACI/CRSI Adhesive Anchor Installation Certification Program.

3.4 EXPANSION, SCREW AND UNDERCUT ANCHORS

A. Expansion, screw, and undercut anchors shall be installed using all procedures and accessory devices recommended by the anchor manufacturer.

End of Section

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SCOPE

A. This section covers miscellaneous items indicated on the Drawings to be of wood construction. Rough carpentry shall include the following:

1. Wood nailers and blocking at edge of roof and top of walls.

2. Plywood.

3. Rough hardware and fasteners.

1.2 SUBMITTALS

A. Submittals will not be required for items covered in this section.

1.3 PROTECTION AND STORAGE

A. Lumber shall be protected and kept under cover, both in transit and at jobsite. Lumber shall be carefully stacked on suitable supports in a manner which will ensure proper ventilation and drainage.

B. All lumber shall be delivered to the jobsite bearing grade stamps of the Northeastern Lumber Manufacturers' Association (NeLMA) or Southern Pine Inspection Bureau (SPIB). All lumber shall be segregated by grades. Extreme care shall be exercised in unloading the lumber to prevent damage, splitting, or breaking of materials.

C. All plywood shall be identified according to species, grade, and glue type by the stamp of the American Plywood Association or equal.

PART 2 - PRODUCTS

2.1 MATERIALS

Lumber	American Standard Lumber conforming to PS20, moisture content 19 percent or less; sized dry, SPF Structural No. 2 or better.
Pressure Treated	Southern Yellow Pine, Structural No. 1 or better, pressure treated with waterborne preservative in

	accordance with AWPA C2 and AWPB LP-22. (CCA IS NOT ALLOWED) alkaline copper quat (ACQ types B and D) or copper azole (CBA-A, CA-B). All anchors, nails, or screws in contact with pressure treated lumber shall be hot dipped or stainless steel.
Plywood	
General Purpose	PS1, waterproof, resin-bonded, exterior type; APA Group 1, Grade Ext-BB, or better unless otherwise specified.
Sheathing, Fire Retardant	FR-S rated plywood, APA rated sheathing, exterior, span rating 32/16, Exposure 1, 3/4 inch thick, pressure treated with fire retardant chemicals, Hickson "Dricon".
Bolts and Nuts	ASTM A307, galvanized ASTM A153, Type NS, or zinc-plated ASTM B633, SC-4.
Wood Screws	18-8 stainless steel or brass or Galvanized steel G-185 coatings for hot-dipped galvanized or class ratings of 40 or above when using electrogalvanized.
Nails	Galvanized or aluminum coated.
Rough Hardware	Galvanized steel, 18-8 stainless steel, brass, or aluminum.

2.2 ROUGH CARPENTRY

A. Rough carpentry shall include lumber work generally, except finish work.

B. The Contractor shall install all wood framing, blocking, and nailers as indicated on the Drawings or required to complete a finished building. In addition to all framing indicated on the Drawings, nailers, blocking, and other backing required for other work and trades shall be installed.

C. At all times during execution of this portion of the contract, sufficient workmen and supervisors shall be present who are thoroughly familiar with rough carpentry construction and the materials and techniques specified or indicated on the Drawings.

D. All rough carpentry shall produce joints true, tight, and well nailed, with all members assembled in accordance with the Drawings and with all pertinent codes and regulations.

E. Individual pieces of lumber shall be selected so that obvious defects will not interfere with the placement of bolts, proper nailing or making of joints. All pieces with defects which render

them unusable shall be discarded. Individual pieces of lumber which are too small to use in fabricating the work with minimum joints shall be discarded.

F. Whether or not lumber has been installed, it may be rejected by the Engineer for excessive splits, warp, twist, bow, crook, mildew, or fungus, as well as for improper cutting and fitting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Rough Carpentry

1. Carpentry work shall be set to required levels and lines, with members plumb and true.

2. Carpentry shall be securely attached to substrates by anchoring and fastening as indicated and as required for strength and by recognized standards.

3. Framing members shall not be bored or cut for pipes, ducts, conduits, or for any other reasons except where accepted by the Engineer.

4. The premises shall be kept in a neat, safe, and orderly condition at all times during the execution of this portion of the work and shall be free from accumulation of sawdust, cut ends, and other debris.

5. Connections between members shall be tight. Washers shall be provided under all bolt heads and nuts in contact with lumber. Installation of fasteners shall not cause splitting of wood.

6. Structural lumber in exterior locations; lumber in contact with concrete, masonry, earth, or water; and all wood nailers shall be pressure treated unless otherwise specified.

B. Nailers

1. Nailers shall be provided where indicated on the Drawings. The nailers shall be continuous and shall be installed level and straight. Each section of nailer shall be secured by at least two anchor bolts.

End of Section

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SECTION 06 74 13 - FIBERGLASS REINFORCED GRATINGS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the fabrication and installation of fiberglass reinforced (FRP) grating.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; values expressed in inch-pound units shall govern.

1.2 GENERAL.

A. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.3 SUBMITTALS.

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Detailed fabrication and erection drawings, indicating location of grating supports, profiles, thicknesses, piece lengths and widths, markings of panels, and fastening methods.

3. Analysis data signed a sealed by a professional engineer licensed in the state of the project.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Delegated Design.

1. Design of all items covered under this section shall be performed by a professional engineer licensed in the state of the project.

B. Design Criteria.

1. FRP grating shall be designed and fabricated to support 100 psf live load with a maximum deflection not greater than L/150 or 1/4 inch , unless indicated otherwise on the Drawings.

C. Pultruded Fiberglass Grating.

1. Fiberglass grating shall be pultruded type unless molded type is indicated on the Drawings. Pultruded grating shall have 6 inch cross bar spacing. Pultruded grating shall have a surfacing veil and UV inhibitors in the resin. Resin shall be vinylester or polyester as required for the chemical exposure service conditions. Walking surfaces shall have a grit finish.

D. Molded Fiberglass Grating.

1. Molded fiberglass grating shall have a square mesh pattern. Resin shall be vinylester or polyester as required for the chemical exposure service conditions. Walking surfaces shall be concave or have a grit finish.

2.2 MATERIALS.

Pultruded FRP Grating	ASTM E84, D635. Vinyl ester resin, ASTM E84 flame spread of 25 or less; Fibergrate Composite Structures "Safe-T-Span", Strongwell "Duradek" or "Duragrid", Seasafe "GatorDeck".
Molded FRP Grating	ASTM E84, D635. Isophthalic polyester resin, ASTM E84 flame spread of 25 or less; Fibergrate Composite Structures "Molded Grating", Strongwell "Duragrate", Seasafe "GatorGrate".
Grating Stair Treads	Grating stair treads shall match the material and finish of grating in adjacent platforms and floors. Treads shall have a permanently attached or integral non-skid nosing.
Grating Fasteners	Manufacturer's standard, AISI Type 316 stainless steel.
Clips, Bolts, Nuts, Washers	Manufacturer's standard, AISI Type 316 stainless steel.

Fiberglass Grating Support Legs	Adjustable fiberglass legs specifically designed to support elevated molded fiberglass grating. Manufactured by the same company supplying the grating.
Fiberglass Curb Angle	Vinyl ester resin, fiberglass trim angle with integral concrete anchorage. Manufactured by the same company supplying the grating.

2.3 FABRICATION.

A. Grating shall be fabricated in panels that can be easily handled by plant personnel. Unless otherwise indicated on the Drawings, the weight of individual panels shall not exceed 150 lbs . Cross bars and edge bars of adjacent panels shall align. After installation, there shall be not more than 1/4 inch clearance between panels. All bearing bars shall be parallel. Bands and toeplates shall align within 1/8 inch tolerance, vertical and horizontal.

B. Grating panels shall be arranged so that openings are centered on a joint between panels. Toeplates extending the full depth of the grating and four inches above the top shall be provided around openings. Toeplates shall be welded to each bearing bar. The ends of bearing bars need not be banded unless required by the Drawings. Bands shall be attached to the first, the last, and every fourth intermediate bar. Bands and toeplates shall be 3/16 inch thick. Crossbars shall be cut off flush with the outside face of side bars.

C. The anchorage of fiberglass curb angles shall consist of intermittent embedded shapes or interlocking deformations on the back side of the angle.

2.4 SHOP COATING.

A. All cut edges of FRP grating shall be sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating or as specified by the manufacturer. Sufficient quantities of edge repair coating shall be supplied with the grating.

PART 3 - EXECUTION

3.1 GENERAL.

A. All grating shall lie flat, with no tendency to rock when installed. Poorly fitting or damaged grating shall be rejected. Grating openings may be field cut with the approval of Engineer, provided that no more than four consecutive bearing bars are cut. If the grating is cut or modified in the field, affected surfaces shall be repaired or sealed to assure restoration of the corrosion resistance of the grating. Field cut openings must be spaced so that there are at least as many continuous bars between each opening as there are cut bars at the opening.

3.2 ATTACHMENTS TO SUPPORTING STRUCTURE.

A. All grating supported on structural elements shall be attached. Grating shall be attached to the supporting structure in accordance with the grating manufacturer's recommendations. Single span grating over openings in concrete may rest unattached in recesses constructed for that purpose.

B. Fiberglass Supports.

1. Unless indicated otherwise on the Drawings, fasteners may be clip, anchor block, or stepped type. Clip fasteners shall be secured to the supporting structural members with power-actuated nails or with threaded studs in drilled holes.

3.3 FINISH TOUCHUP.

A. After erection, all grating shall be cleaned. Grating pieces shall be sealed with catalyzed resin sealant of equal or superior corrosion resistance to the grating itself or repaired in accordance with the manufacturer's recommendations to assure full undamaged performance.

End of Section

SECTION 06 82 00 – FIBERGLASS REINFORCED FABRICATIONS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of fiberglass reinforced plastic (FRP) fabrications. FRP structural shapes, grating, railings, and ladders are specified in other sections.

B. The following products shall be provided:

Parshall Flume Liners.

Quantity.	1
Tag number(s).	FLM-3000
Flume designation(s).	Effluent Flow Meter

1.2 GENERAL

A. The items furnished under this section shall be provided by a manufacturer who has at least 10 years of experience in the design, manufacture, fabrication, and installation of FRP systems.

1.3 SUBMITTALS.

A. All submittals shall be made in accordance with the Submittal Procedures section.

B. The following items shall be submitted, as a minimum.

1. Manufacturer’s information for all products supplied under this section, in the form of technical data sheets, certificates of compliance, test data, or reports.

2. Detailed fabrication drawings, including each member’s piece mark and dimensions.

3. A standard calibration curve or tabulation for each flume liner shall be prepared and certified by the manufacturer. Each calibration curve or tabulation shall show the flow at various levels, shall cover the entire specified range of flow, and shall be legible to within 0.5 percent of the flow at any point.

4. Samples of all products, when requested by Engineer.

5. Structural calculations, when requested by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

FRP Fabrications	Vinyl ester resin, with a UV inhibitor. Strongwell, Fibergrate, or approved equal.
Longitudinal Tensile Strength	20,000 psi minimum, ASTM D638.
Longitudinal Tensile Modulus	1,800,000 psi minimum, ASTM D638.
Longitudinal Flexural Strength	24,000 psi minimum, ASTM D790.
Longitudinal Flexural Modulus	1,100,000 psi minimum, ASTM D790.
Full Section Modulus of Elasticity	2,000,000 psi minimum.
Flame Spread Rating	25 or less, in accordance with ASTM E84.
Visual Requirements	ASTM D4385.
Fasteners	Type 316 stainless steel.

A. All materials and components of fiberglass fabrications for use in potable water facilities shall meet the applicable requirements of NSF/ANSI 61 and NSF/ANSI 600.

B. All surfaces of plastic laminate shall be sealed with a resin layer at least 5 mils thick.

2.2 WEIR PLATES

A. Weir plates shall be molded style as manufactured by Plasti-Fab, Warminster, Nefco, MFG Water Treatment Products, or approved equal. Weir platesshall be 1/4 inch [6 mm] thick and shall be fabricated to the shape indicated on the Drawings. The top surface shall be molded to shape and the top edge of each plate shall be straight within 1/32 inch. Molded surfaces shall be resin rich, free of voids, porosity, exposed glass, cracks or crazes.

B. The depth of the scum baffle shall be increased upstream and downstream of the scum beach as indicted on the Drawings.

C. Each weir plate shall be designed so that at least 2 inches of horizontal and vertical adjustment is provided. Fiberglass splice plates shall be provided to secure the ends of the weir plates. Splice plates shall be designed to accommodate expansion and contraction.

D. Design for snow, wind, and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Weir plates shall be fabricated in accordance with ANSI/AWWA F102-07.

F. Contractor shall coordinate the weir plates with all perimeter guardrails, guardrail support brackets, launder covers, and launder cover support brackets that are supplied by others.

2.3 PARSHALL FLUME LINER

A. Flume liners shall be as manufactured by Plasti-Fab or Warminster, and shall conform to the following requirements.

Tag number	FLM-3000	
Throat width.	12	in
Minimum flow.	0.25	mgd
Maximum flow.	6	mgd
Height of sidewalls above floor of approach section.	66	in
Minimum wall thickness.	3/16	in

B. The liner shall be accurate in all dimensions and shall include, in one integral piece, the approach, throat, and downstream sections. Each section shall have a floor and vertical sidewalls. The inside surfaces shall have a gel coat layer not less than 10 mil thick and shall be smooth and free from irregularities. Flanges and anchors shall be provided as necessary on the outside surfaces to ensure that the liner will be permanently anchored to the concrete. A threaded connection shall be provided in the approach section for the line to the floatwell.

C. The liner shall be stiffened and braced so that the deflection caused by concrete placement shall not exceed 1/16 inch at any point. Internal braces shall be readily removable after concrete is placed, without damage to the inside surfaces of the liner. All permanent reinforcing members shall be completely encased in plastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Weir Plates

1. Surfaces in contact with concrete shall be given a heavy coating of sealant as specified in the Caulking section before installation. Weir plates shall be adjusted after installation to provide uniform overflow rate at all points.

B. Parshall Flume Liner

1. The liner shall be carefully leveled and rigidly braced and anchored in position before the adjacent concrete is placed.

3.2 FIELD COATING

A. Field Cut Surfaces

1. Field-cut surfaces shall be recoated with resin obtained from the fabricator.

End of Section

SECTION 07 53 23.19 - SINGLE-PLY ROOFING, FULLY ADHERED

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installing of a fully adhered, TPO single-ply membrane roof system complete, with vapor retarder, adhesives, fasteners, flashings, insulation, and accessories.

1.2 GENERAL

A. Except as otherwise indicated on the Drawings, all new roof decks shall be covered with insulated, fully adhered single-ply membrane roofing system as indicated. The finished roof shall be watertight under all conditions of weather and service except physical damage due to unforeseen causes.

B. The roof system shall meet UL rating Class A and shall be designed to withstand 90 mph peak wind gusts for a minimum three seconds without damage.

C. Unless indicated otherwise, a complete total system guarantee covering all elements of the roofing system shall be furnished with this work. A warranty or guarantee which covers only the membrane will not be acceptable.

1.3 SUBMITTALS

A. Complete specifications and data covering the roofing systems and materials furnished under this section shall be submitted in accordance with the Submittals Procedures section.

B. Drawings shall be submitted showing outline of roof area and roof size, locations and types of roof penetrations, perimeter and penetration details, splice details, special details as needed, and installation instructions.

C. Drawings shall be submitted showing the insulation manufacturer's recommended layout for each area of insulation boards and crickets.

D. Samples of the roofing membrane, insulation, and fasteners shall be submitted. Test data for pullout resistance for fastening systems shall be provided.

E. Data shall be submitted showing compliance with UL requirements for the Class rating and the Factory Mutual wind uplift classification as indicated.

F. Evidence shall be submitted which shows the roofing system installer to be an authorized applicator of the system furnished.

1.4 SUBCONTRACTOR'S QUALIFICATIONS

A. Subcontractor shall be an installer who has met the highest level of installers for that manufacturer's roofing system. Subcontractor shall submit a qualification letter from the roofing manufacturer stating that the roofing contractor is an applicator and is able to offer the 30-year Total System NDL Guarantee required for this specific project. This qualification letter must accompany bid to the General Contractor.

B. Unless indicated otherwise on the Drawings, work under this section shall be done by a qualified roofing subcontractor who has been in business for at least 5 years. The work shall be inspected by a representative of the membrane manufacturer to verify that materials and methods of application are in accordance with the recommendations of the manufacturer and with these specifications.

C. Subcontractor shall coordinate and attend a pre-construction roof meeting with the General Contractor and the roofing manufacturer's technical representative prior to roof installation. Subcontractor shall submit a NOA (Notice of Award) and project information to roofing manufacturer prior to project start.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Materials shall be delivered in original, unopened containers labeled with the manufacturer's name, brand name, installation instructions, and identification of various items. All materials for the roofing system shall be stored and handled in accordance with the recommendations of the manufacturer.

1.6 GUARANTEE

A. Unless otherwise indicated, the manufacturer of the roofing membrane shall furnish to Owner, through the roofing subcontractor, a non-prorated, no dollar limit (30 year No Dollar Limit Guarantee), total roof system guarantee covering the workmanship and application of the roofing system including membranes, insulation, fasteners, vapor retarder, and flashings for a period of 30 years from the date of acceptance.

B. The guarantee shall provide for the repair of the total roofing system including repairs to membrane, flashings, counterflashings, insulation, barrier and cover boards, if required, fasteners, vapor retarder, adhesives and sealants resulting from all leaks in the membrane and base flashings that may occur due to defective materials, improper workmanship, and normal weather conditions. Unless otherwise indicated, the warranty shall include wind uplift protection to mph peak gusts. The guarantee shall also provide limited coverage for hail damage.

C. In addition, the manufacturer shall also provide a separate material warranty covering the membrane for not less than 30 years against premature deterioration because of weather.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless noted otherwise, all materials used in construction of the roof system shall be furnished by the same manufacturer. Materials shall be manufactured by firms of national reputation.

B. In order to indicate type, quality, and features required, this specification is based on GAF Everguard Extreme TPO fully adhered system. Equivalent roofing systems manufactured by other manufacturers may also be acceptable provided the requirements of these specifications are met.

C. Materials shall conform to the following:

Roofing and Flashing Membrane, White	GAF Everguard 80mil fleece back Extreme TPO
TPO Adhesive	Two-part low rise polyurethane foam adhesive. VOC free and contains no solvents.
Fasteners	Membrane manufacturer's standard. As recommended by roofing membrane manufacturer.
Water Cutoff Mastic	Membrane manufacturer's standard.
Night Sealant	Membrane manufacturer's standard.
Seam Fastening	Membrane manufacturer's standard.
Molded Pipe Flashing	Membrane manufacturer's standard.
Pourable Sealer	Membrane manufacturer's standard.
Cover Board	1/2” high density polyisocyanurate board (HD ISO Board). A COVER BOARD IS REQUIRED.
Walkways	TPO walkway roll, 30-inch minimum width, 125-mil minimum thickness, standard gray color. Spacing between rolls per manufacturer’s installation requirements. Maximum length shall be 5’-0”.
Insulation	
Polyisocyanurate	Minimum thickness at scupper low points as indicated on the Drawings, slope as indicated on the Drawings. R-30 average over entire roof. (Final insulation thickness to be determined by manufacturer as necessary to obtain required R-value).

Cricket System	Insulation manufacturer's standard factory pre-cut cricket system, pattern as indicated on the Drawings.
Vapor Retarder	2 plies of roofing felt, ASTM D-2178, Type IV.
Mechanical Fasteners	
Metal Deck Applications	Corrosion resistant type for metal deck specified, Factory Mutual approved for roof insulation used, and for fire and wind resistance requirements specified.

D. Unless otherwise specified, metal copings, counterflashings, cap flashings and similar metal components are covered in the Sheet Metal section but shall be covered in the “30 Year Total System NDL Guarantee”.

PART 3 - EXECUTION

3.1 INSPECTION

A. The roofing membrane manufacturer's representative and the roofing subcontractor shall conduct all required inspections and shall submit to the roofing manufacturer all required drawings, details, and completed questionnaires for obtaining the specified warranty.

B. A job start observation will be required with roofing manufacturer’s technical representative present at project start. The representative shall witness actual roofing installation and shall submit a letter to the General Contractor and the Engineer stating that the observed installation met the recommendations of the roofing manufacturer.

3.2 PREPARATION OF ROOF SURFACES

A. Roof surfaces shall be cleaned and inspected before any roofing materials are applied. All drainage fixtures shall be set at the proper elevation to permit free flow of water.

B. The roof surfaces to be covered shall be smooth, hard, dry, and free from high spots, depressions, and frost or effects of frost. Roof surfaces shall be swept clean and free from dust, loosened cement scale, and debris. Roof surfaces shall be examined for openings, holes, or crevices which might allow adhesives or sealants to drip or flow through the deck or between the deck and vertical projections. Such openings shall be filled or covered before any roofing materials are applied.

3.3 APPLICATION OF ROOFING

A. System

1. The materials for the roofing systems shall be as specified herein. The roofing system assemblies shall conform to the following systems as indicated on the Drawings.

B. Nailers

1. Nailers shall be as specified in the Rough Carpentry section. Nailers shall be secured as specified by the roofing membrane manufacturer and as specified by FM Bulletin 1-49. Wood nailers shall be installed at the locations specified herein, as indicated on the Drawings, and as recommended by the membrane manufacturer.

C. Vapor Retarder for Metal Deck

1. A bottom layer of a gypsum-based board meeting ASTM C1177 shall be installed over metal roof decks as indicated. The layer of gypsum-based board shall be anchored to the metal roof deck with mechanical fasteners in accordance with FM Bulletin 1-28 and the FM Approval Guide. Installation of the mechanical fasteners shall be in accordance with the manufacturer's recommendations. The board shall be completely covered with a vapor retarder as per the manufacturer’s written recommendations. The vapor retarder shall be flashed at all penetrations, curbs, and parapets to prevent entry of moisture.

2. The vapor retarder shall not be used as a temporary roof.

D. Insulation

1. Insulation shall be dry when installed. No more insulation shall be installed than can be covered with roofing membrane before the end of the day's work or before the onset of inclement weather.

2. Unless otherwise specified, insulation shall be laid over the substrate, with joints no wider than 1/4 inch. Joints wider than 1/4 inch shall be filled with the same insulation.

3. Insulation boards shall be laid with joints staggered between parallel courses and, if required, between layers. Abutting edges of boards shall be laid in moderate contact, not forced into place. At vertical surfaces, insulation shall be cut neatly to provide a clearance of not more than 1/4 inch.

4. Insulation boards for tapered systems shall be positioned in accordance with the manufacturer's layout to produce roof slopes and drainage patterns as indicated on the Drawings. The installed thickness of insulation shall be as indicated on the Drawings.

5. Crickets to provide positive roof drainage as indicated on the Drawings, shall be installed as indicated on the Drawings and per the manufacturer's instructions.

6. When high wind uplift is required, anchorage of insulation boards and cover boards shall be provided complete with all necessary anchors, special anchors, and appurtenances to meet the performance and warranty requirements.

E. Cover Board

1. Cover boards shall be installed over all insulation. Cover boards shall be attached as recommended by the membrane manufacturer for the wind design specified.

F. Membrane

1. The roofing membrane shall be positioned over the installed insulation without stretching. Membrane shall be allowed to relax for approximately 1/2 hour prior to bonding.

2. Sheets of membrane shall be positioned to provide a 3 inch minimum edge lap with adjacent sheets. Adhesive shall be applied to the membrane and the underlying substrate to securely bond the membrane to the board according to the manufacturer's recommendations. Membrane shall be rolled to eliminate wrinkles, pockets, or voids. Joints in the membrane shall be cleaned and permanently joined at the overlap as recommended by the membrane manufacturer. Special care shall be taken to minimize staining and damage to the exposed membrane surfaces by the sealants.

3. At the end of each day or whenever application of roofing is interrupted, temporary water cutoffs shall be installed at loose edges as recommended by the membrane manufacturer. When work is resumed, the sheet shall be pulled free and trimmed to remove membrane where sealant was previously applied.

G. Securing Perimeter Membrane

1. Sheets of membrane shall be secured at the perimeter of each roof level, roof section, curb, skylight, expansion joint, penthouse, and parapet wall, where required, using fastening strips or reinforced universal securement strips mechanically fastened through the membrane and insulation into the wood blocking or structural substrate as recommended by the membrane manufacturer.

H. Flashing

1. Perimeter, wall, roof edge, expansion joints, parapet, and curb flashings, where required, of TPO membranes shall be provided and installed as recommended by the membrane manufacturer. All pipe, conduits, or other roof penetrations shall be flashed with molded pipe flashings and the manufacturer's recommended water cutoff mastic.

I. Walkways

1. Roof walkways shall be installed where indicated on the Drawings and in accordance with the membrane manufacturer's recommendations.

J. Cleanup

1. Following installation of roofing materials, the roof surface shall be cleaned of all construction materials, traffic grime, accumulated dirt, excess sealants, and other debris. The membrane surface shall be cleaned as recommended by the membrane manufacturer.

End of Section

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Section 07 60 00

SHEET METAL

PART 1 - GENERAL

1-1. SCOPE. This section covers sheet metal associated with rainwater drainage and miscellaneous flashings around roof and wall openings. The following sheet metal items are covered in other sections:

a. Ductwork, and other sheet metal for the heating, ventilating, and air conditioning system.
b. Steel roof deck.
c. Roof-to-wall flashing provided by the metal roof panel manufacturer.

1-2. GENERAL. Installation of wall and roof flashings shall be as indicated on the Drawings.

Flashing members to be built into concrete, masonry, or roofing shall be delivered at the proper time for incorporation into the work.

When installing sheet metal items, care shall be taken to avoid marring and improper bending. All components shall be stored in clean, dry storage areas. Contact with corrosive or staining materials shall be prevented. All damaged sections shall be replaced and only undamaged units shall be installed.

1-3. SUBMITTALS. Complete specifications, data, and catalog cuts or drawings covering the items furnished under this section shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2-1. MATERIALS.

Stainless Steel	ASTM A167, Type 302 or 304, AISI 2B finish unless otherwise specified.

Sheet Aluminum	ASTM B209, Alloy 3003-H14, mill finish.
Extruded Aluminum	ASTM B221, Alloy 6053 or 6063.
Solder	ASTM B32, Alloy Grade 50A (50-50).
Soldering Flux	
For Stainless Steel	Zinc chloride type, Fed Spec 0-F-506, Type II.
For Other Metals	Acid type, Fed Spec O-F-506, Type I, Form A.
Fasteners	Same metal as sheet metal being fastened.
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Acrylic Sealant	Pecora "Unicrylic" or Tremco "Mono".

2-2. EXPOSED METAL. All exposed or contacting metal and flashings shall be of the same material.

2-2.01. Types and Materials.

Downspouts	Pre-finished .032 inch aluminum with an oven baked 70 percent “Kynar 500” fluoro-polymer coating; flush surface, 5” X 5”, complete with strap hangers. Color to match the metal roof panels.
Scuppers	Pre-finished 0.032 inch aluminum with an oven baked 70 percent “Kynar 500” fluoro-polymer coating; size and profile as shown in the drawings. Color to match the metal roof panels.
Miscellaneous Metal Flashings	Stainless steel, 26 gauge.

2-3. SCUPPERS AND DOWNSPOUTS. Metal scuppers and downspouts shall be provided and installed as indicated on the Drawings and specified herein. The scuppers and downspouts shall be furnished and installed complete with all accessories as specified or required to complete the installation.

Scuppers and downspouts shall be well constructed, watertight, properly secured to the structure, and installed according to the Drawings and recommendations of SMACNA (latest edition). Downspouts shall be supported at the top and bottom and at 6’-0” maximum intermediate spacings.

Downspouts shall be constructed from aluminum and shall have all exterior surfaces covered with a baked enamel finish.

Finish shall be a 20-year “Kynar 500” based fluropolymer coating. The scupper and downspout color will be selected from manufacturer's standard and custom color charts as required to match existing sheet metal on existing Filter Building.

2-4. MISCELLANEOUS METAL FLASHING. Metal flashings shall be provided for vents, sleeves, and similar projections through the walls.

PART 3 - EXECUTION

3-1. WATERTIGHT JOINTS. Joints in sheet metal work shall be closed watertight unless slip joints are specifically required. Watertight joints shall be mechanically interlocked and then thoroughly soldered for metals other than aluminum. Joints in aluminum or between aluminum and other metals shall be sealed with acrylic sealant.

All joints shall be wiped clean of flux after soldering. Acid flux shall be neutralized by washing the joints with sodium bicarbonate.

3-2. PROTECTION. Adequate protection shall be provided during shipment, site storage, and installation, to prevent damage to materials or finished work.

Aluminum to be placed in contact with concrete, mortar, or dissimilar metals shall be given a heavy coat of coal tar paint.

End of Section

SECTION 07 84 00 - FIRESTOPPING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the firestopping of penetrations through fire rated assemblies in floors, walls, ceilings, and roofs.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Only tested firestop systems shall be used in specific locations as follows:

1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways, and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

2. Safing slot gaps between edge of floor slabs and curtain walls.

3. Openings between structurally separate sections of wall or floors.

4. Gaps between the top of walls and ceilings or roof assemblies.

5. Expansion joints in walls and floors.

6. Openings and penetrations in fire-rated partitions or walls containing fire doors.

7. Openings around structural members which penetrate floors or walls.

1.4 REFERENCES

A. Test Requirements: ASTM E-814, "Standard Method of Fire Tests of Through Penetration Fire Stops" (July 1997).

B. Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

C. Test Requirements: UL 2079, “Tests for Resistance of Building Joint Systems” (July 1998).

D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

E. Inspection Requirements: ASTM E 2174 – 01, “Standard Practice for On-site Inspection of Installed Fire Stops.”

F. International Building Code (2015)

1.5 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

D. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

1.6 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL approved assemblies to be used and manufacturer's installation instructions to comply with the Submittal Procedures section.

B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to jobsite.

1.7 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacture's products per specified requirements.

PART 2 - PRODUCTS

2.1 FIRESTOPPING, GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ) and joint systems (XHBN) listed in Volume II of the UL Fire Resistance Directory; provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma, 800-879-8000

2. W.R. Grace and Co.,62 Whittemore Avenue, Cambridge, MA, 866-333-3726

3. 3M, 3M Corporate Headquarters St. Paul, MN, 888-364-3577

4. Or approved equal.

2.3 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E-814, or UL 2079 tested for specific fire rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.

C. Provide a firestop system with an Assembly Rating as determined by UL 2079 which is equal to the time rating of construction being penetrated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

B. Verify penetrations are properly sized and in suitable condition for application of materials.

C. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

D. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

E. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

F. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

B. Responsible trades to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.3 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through penetration and construction joint materials.

C. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.

D. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

E. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.5 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

End of Section

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SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers caulking and sealing. Fire rated caulking is covered in the Fireproofing section.

1.2 GENERAL

A. The terms “caulking” and “sealing,” as used on the Drawings and in these Specifications, are synonymous. Both terms indicate the materials specified herein. Oil-base caulking shall not be used on this Project.

1.3 APPROVALS

A. All caulking shall meet the requirements of the standards specified herein. All caulking and sealing to be used in contact with potable water shall meet the requirements of ANSI/NSF 61 and ANSI/NSF 600.

1.4 SUBMITTALS

A. Drawings and Data

1. Specifications and data covering the materials proposed for use, together with samples or color cards showing the manufacturer’s full line of sealant colors, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 MATERIALS

Thiokol Sealants (polysulfides)	Fed Spec TT-S-00227E, Class A or ASTM 920 Type M; polysulfide rubber, two component.
Nonsag	
Submerged Service, Non potable water	Pecora “Synthacalk GC-2+.”
Nonsubmerged Service	Pecora “Synthacalk GC-2+”; Polymeric Systems “PSI-350.”

Self-Leveling, nonsubmerged	C. Horn “Hornflex Traffic Grade”; Polymeric Systems “PSI-350.”**]]**
Urethane Sealants (Polyurethanes)	Fed Spec TT-S-00227E, Class A, Type 2 and ASTM C920, Type M, Grade NS, two component.
Nonsag	
Submerged Service	
Potable Water	Polymeric Systems “RC-270”; Sika “Sikaflex-2cNS.
Nonpotable Water	Polymeric Systems “RC-270.”
Nonsubmerged Service	Bostik “Chem-Calk 500”; Tremco “Vulkem 227”; Pecora “Dynatrol II”; Tremco “DYmeric 240”; Sika “Sikaflex-2cNS.”
Self-Leveling, Nonsubmerged Service	Bostik “Chem-Calk 550”; Tremco “Vulkem 245”; Pecora “Urexpan NR-200”; Polymeric Systems “RC-2SL”; Tremco “THC-900.”
Acrylic Sealant	Fed Spec TT-S-230; ASTM C834.
	Bostik “Chem-Calk 600”; Pecora “AC20”; Tremco “Mono 555.”
Silicone Sealant	Silicone rubber, neutral color; Dow Corning “Mildew-Resistant silicone 786”; General Electric “Silicone Sanitary 1702 Sealant.”
Primer	As recommended by the sealant manufacturer.
Backup Material	Polyethylene or polyurethane foam as recommended by the sealant manufacturer; Dow “Ethafoam SB” or Plateau “Denver Foam.”
Bondbreaker Tape	Adhesive-backed polyethylene tape as recommended by the sealant manufacturer.

2.2 COLORS

A. Colors of sealants shall be as selected by Engineer from the manufacturer’s standard line of colors. Different colors may be required for different locations.

2.3 LOCATIONS TO BE CAULKED

A. With Thiokol or Urethane Sealant (Nonsag) - Submerged Service

1. All joints requiring caulking in submerged locations.

2. Surface of basin weir plates in contact with supporting structure.

B. With Thiokol or Urethane Sealant (Nonsag) - Nonsubmerged Service

1. Entire perimeter of frames for exterior metal doors.

2. Entire perimeter of metal louvers.

3. Entire perimeter of metal dampers and metal shutters.

4. Entire perimeter of aluminum windows.

5. Control joints in masonry walls.

6. Perimeter of aluminum entrances and assemblies, except exterior side of exterior sills.

7. Joints on the underside of prestressed, precast roof members where exposed to view.

8. Around service sinks.

9. Joints between masonry and cast-in-place concrete, where indicated on the Drawings.

10. Other locations where caulking is indicated on the Drawings, specified in other sections, or required for weatherproofing.

C. With Thiokol or Urethane Sealant (Self-Leveling)

1. Horizontal joints in walks or drives.

2. Horizontal joints in traffic-bearing decks and slabs.

3. Annular space around handrail posts set in sleeves.

D. With Acrylic Sealant

1. Watertight joints in sheet metal work.

E. With Silicone Sealant

1. Around floor urinals

PART 3 - EXECUTION

3.1 JOINT PREPARATION

A. All surfaces to receive sealant shall be clean, dry, and free from dust, grease, oil, or wax. Concrete surfaces which have been contaminated by form oil, paint, or other foreign matter which would impair the bond of the sealant to the substrate shall be cleaned by sandblasting. All surfaces shall be wiped with a clean cloth saturated with xylol or other suitable solvent, and shall be primed before the sealant is applied.

B. Unless otherwise recommended by the sealant manufacturer and permitted by the Engineer, the depth of sealant in a joint shall be equal to the width of the joint, but not more than 1/2 inch. Backup material shall be provided as necessary to control the depth of sealant and shall be of suitable size so that, when compressed 25 to 50 percent, the space will be filled. Backup material shall be rolled or pressed into place in accordance with the manufacturer's installation instructions, avoiding puncturing and lengthwise stretching. If depth of the joint does not permit use of backup material, bondbreaker tape shall be placed at the bottom of the joint to prevent three-sided adhesion.

3.2 SEALING

A. Sealing work shall be done before any field painting work is started. The air temperature and the temperature of the sealed surfaces shall be above 50° F when sealing work is performed.

B. Upon completion of the sealing work, each sealed joint shall have a smooth, even, tooled finish, flush with the edges of the sealing recess, and all adjacent surfaces shall be clean. Sealant shall not lap onto adjacent surfaces. Any sealant so applied as to prevent the painting of adjacent surfaces to a clean line, or with an excess of material outside the joint and feathered onto surfaces, shall be removed and the joint resealed.

End of Section

SECTION 08 11 50 - FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers fiberglass reinforced plastic doors and frames. Unless otherwise indicated or specified, all FRP doors shall be flush type. All doors and frames shall be provided by a single manufacturer.

B. Finish Hardware is covered in the Finish Hardware section. Glazing is covered in the Glass and Glazing section.

1.2 GENERAL

A. Doors, frames, and appurtenances shall be furnished and installed as specified herein and in accordance with the details and arrangements indicated on the Drawings.

B. Subject to the requirements specified herein, FRP doors shall be equivalent to Chem-Pruf "CP1" FRP doors. Fire-rated doors shall be equivalent to Chem-Pruf "CP3" FRP doors.

1.3 SUBMITTALS

A. Complete detail drawings of all items specified herein shall be submitted in accordance with the Submittals Procedures section. Drawings shall show elevations of each door type; details of each frame type; location or identification of each item; typical and special details of construction; methods of assembling sections; location and installation requirements for hardware; size, shape, and thickness of materials; joints; connections; and finish.

B. Submitted equivalent FRP door manufacturers will not be acceptable if the door face sheet thickness cannot be verified as an equivalent to the minimum thickness in inches as specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials used in the manufacture and installation of FRP doors and frames shall be as follows:

Doors	Fiberglass reinforced plastic face sheets, 0.125-inch minimum thickness, polypropylene honeycomb core (gypsum mineral core in fire-rated doors), manufacturer 25-year warranty.

Fire-rated	UL 10(b) / UL 10(c), hour rating as indicated on the Drawings.
Internal Reinforcing	Manufacturer's standard.
Frame	Solid, all-fiberglass frame with molded-in color conforming to SDI dimensions for profiles shown.
Face Sheet	Fine pebble textured, semi-gloss gel coat finish, minimum 15mil thickness, abuse-resistant engineered surface.
Astragals	5/16” x 2-1/2” x door height, FRP construction matching door color. Provide where specified in the Finish Hardware section.
Anchoring Devices	Stainless steel.

B. Shop Finish

1. The finished surfaces shall be smooth and free from irregularities. The color for the new FRP doors will be selected from the manufacturer’s full line of standard and optional colors. A manufacturer provided color chart and sample shall be provided for color selection. Generically printed color charts will not be acceptable.

2.2 FRAMES

A. Frames for doors shall be formed of fiberglass reinforced plastic shapes with molded-in color shall be a minimum 3/16 inch in thickness for the profile indicated on the Drawings, with approximately 2-inch face as indicated on the Drawings. The frame face shall be sized according to the actual size and width of the opening provided. Resins for frames shall match those used for doors.

B. Workmanship

1. The finished work shall be strong and rigid, neat in appearance, and free from defects. Molded members shall be fabricated straight and true, with corner joints well formed, and with fastenings concealed where practicable.

C. Joints

1. Joints for frames shall be mitered or butted and continuously sealed on the reverse side to produce rigid joints which are invisible on the face of the frame. Frame bottoms shall be held rigidly in position by spreader bars to maintain proper alignment during shipment and erection.

D. Hardware Provisions

1. Frames shall be prepared at the factory for the specified hardware. Frames shall be mortised, reinforced, drilled, and tapped for mortised hardware, and shall be reinforced for surface- applied hardware. Cover boxes shall be provided in back of all hardware cutouts.

2. Fiberglass reinforced plastic frames shall have concealed reinforcements for hardware according to manufacturer's standards.

E. Wall and Floor Anchors

1. Metal anchors shall be of the sizes and shapes required for the type of adjoining wall construction. Jamb anchors shall be located near the top and bottom of each frame and at intermediate points not to exceed 32 inch spacing.

2.3 DOORS

A. Doors indicated on the Drawings as flush fiberglass reinforced plastic, including doors with glazed openings, shall be as specified herein. Doors shall be prepared to receive the hardware specified in the finish hardware section.

B. Workmanship

1. Doors shall be rigid, neat in appearance, and free from defects. Molded members for glazed doors shall be formed straight and true, with joints coped or mitered, well formed, and in true alignment. All joints on exposed surfaces shall be smooth so that they are invisible after finishing.

C. Sizes and Clearances

1. Doors shall be 1-3/4 inches thick, full flush type, of the sizes and design indicated. Clearances for doors shall be 1/8 inch at jambs and heads, 1/4 inch at meeting stiles of pairs of doors, and 3/4 inch at bottom unless otherwise indicated or specified.

D. Construction

1. Doors shall be constructed with at least 0.125-inch fiberglass reinforced plastic outer sheets. Side edges of doors shall be flush and closed watertight. All seams shall be continuously sealed. Doors shall be prepared at the factory for hardware and for glazing as indicated on the Drawings and as specified.

2. Outswinging exterior doors shall be finished flush at the top, with all seams and joints closed watertight as specified for side edges.

E. Hardware Provisions

1. Doors shall be mortised, reinforced, drilled, and tapped for mortised hardware. Reinforcing units shall be provided for locksets. Reinforcing plates shall be provided for mortised and surface-applied hardware according to manufacturer's standards.

2. The location of hardware items shall be in accordance with DHI "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames".

F. Astragals

1. The meeting edges of double doors shall be provided with a matching FRP flat bar astragal from the door manufacturer where specified in the Finish Hardware section. Astragals shall be applied to the active leaf.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Frames shall be set in position, plumbed, aligned, and braced securely until permanent anchors are set.

B. Frames set in existing or new walls shall be anchored to walls with non-corroding expansion anchors or as otherwise required by frame manufacturer. Frame placement within the wall construction shall be as indicated on the Drawings.

End of Section

SECTION 08 33 23.33 - OVERHEAD COILING ALUMINUM DOORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of insulated and uninsulated rolling aluminum doors. Doors shall be overhead coiling type, of the sizes indicated on the Drawings, complete with necessary guides, hoods, hardware, fastenings, mechanisms, and accessories as specified or as indicated on the Drawings.

B. Motor operated doors shall be installed complete and in proper operating condition in the openings indicated on the Drawings. Electrical conduit and wiring from the power source to the door control equipment, to motors, and to disconnect switches will be furnished and installed under the electrical sections. Review electrical drawings and specifications.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated, assembled, and installed in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Details of doors, guides, hoods, and accessories shall be as indicated on the Drawings and as specified herein. Doors shall be the product of a manufacturer who is regularly engaged in manufacturing the items specified.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Power Supply

1. Power supply to electric operators will be 480 volts, 60 Hz, 3 phase, unless otherwise indicated on the Drawings.

F. Metal Thicknesses

1. Metal thicknesses and gages of sheet metal specified herein are the minimum required. Gages refer to American or B&S gage.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete detail and installation drawings shall be submitted in accordance with the Submittals Procedures section. Drawings shall indicate construction details, clearance requirements, metal thicknesses, finish, counter balancing, and method of anchoring, locations of guides**[**,, switches, controls, power requirements, and wiring diagrams**]**.

B. Meteorological and Seismic Design Criteria Compliance

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

C. Operation and Maintenance Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

1.4 DELIVERY, STORAGE AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Doors shall be protected from damage during transportation, at the Site, and during construction. Damaged items will be rejected and shall be replaced.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Rolling aluminum doors shall be of the types, models, and operation specified herein and indicated on the Drawings.

B. Uninsulated Rolling Doors

1. Uninsulated doors shall be Atlas "All Weather Rolling Service Door Series S", Overhead "Stormtite Series 620", or Wayne Dalton "Standard Service Door Series 800".

C. Insulated Rolling Doors

1. Insulated rolling doors shall be Atlas "Insulated Thermal Door Series T", Overhead "Stormtite Insulated Series 625", or Wayne Dalton "Thermotite Series 800C".

2.2 MATERIALS

A. Materials used in rolling aluminum doors shall be as follows:

Curtain and Hood	Aluminum; Sheet - ASTM B209, Alloy 5005-H154; Extrusions - ASTM B221, Alloy 6063-T5.
End Locks	Manufacturer's standard.
Bottom Bar and Guides	Aluminum angles or channels at least 3/16 inch thick.
Bottom Weather Seal	Rubber or vinyl.
Roller Shaft	Steel pipe or tubing.
Roller Ends	Cast iron, ASTM A48.
Spring	Oil-tempered steel.
Brackets and Gearing	Cast iron or steel.
[Operating Chain	Steel; hot-dip galvanized, ASTM A153 and A385; or zinc plated, ASTM B633, SC4.**]**
Slat Insulation	Polyurethane, foamed in place.
Anchor Bolts	As specified in the anchorage in concrete and masonry section.

2.3 ROLLING DOOR FABRICATION

A. Mounting

1. Doors shall be fabricated for installation on the face of the wall, with the hood mounted above the opening as indicated on the Drawings.

B. Uninsulated Door Curtain

1. The curtain for uninsulated doors shall be formed of interlocking flat slats and shall be designed for a **[**25 psf service load and a 40 psf Factored Load per the Building Code.**][***Insert other* loads**]**. The curtain shall roll up on a drum supported at the head of the opening and shall be balanced by helical springs. Slats shall be as follows:

Door Width	Minimum Slat Gage [Thickness]
Under 12 feet	18 (0.040 inch)
Over 12 feet	16 (0.050 inch)

2. The ends of each alternate slat shall have end locks. In addition to end locks, exterior doors shall have windlocks where required by the opening size and the design load.

3. If required by the design load indicated, the ends of each slat in the curtain shall be equipped with a combination end lock and wind lock. Combination end locks shall have a

flat surface engaging a seal of metal or of other suitable material mounted on or in the guides, in a manner which will provide an effective seal against wind and water.

4. Each curtain shall be provided with a bottom bar attached in a manner to suit sill construction. Each exterior door shall be furnished with a replaceable, compressible weather seal fastened to the bottom bar.

C. Insulated Door Curtain

1. The curtain for insulated doors shall be formed of interlocking insulated slats and shall be designed for a **[**25 psf service load and a 40 psf Factored Load per the Building Code.**][***Insert other* loads**]**. The curtain shall roll up on a drum supported at the head of the opening and shall be balanced by helical springs. Slats shall be 3/4 inch thick, formed of an outside face and inside face of .050 aluminum totally enclosing foamed-in-place polyurethane insulation.

2. The ends of each slat in the insulated curtain shall be equipped with a combination end lock and wind lock. Combination end locks shall have a flat surface engaging a seal of metal or of other suitable material mounted on or in the guides, in a manner which will provide an effective seal against wind and water.

3. Each insulated curtain shall be provided with a bottom bar attached in a manner to suit sill construction. Each exterior insulated door shall be furnished with a replaceable, compressible weather seal fastened to the bottom bar.

D. Vision Panels

1. Vision panels shall be provided in doors where indicated on the Drawings.

E. Guides

1. Guides shall form a pocket of sufficient depth to retain the curtain in place under the specified maximum wind pressure. Guides shall be attached to adjacent construction with 3/8 inch non-corroding bolts spaced at not more than 30 inches and near each end.

F. Roller Shaft

1. The roller shaft shall be designed so that deflection does not exceed 0.03 inch per foot of span. Ends of the roller shall be closed with plugs machined to fit and fastened with pins or screws. Welding will not be acceptable. The counterbalancing spring installed inside the roller shall be capable of producing sufficient torque to permit easy operation of the curtain from any position. The spring tension shall be adjustable from outside the bracket without removing the hood, except for manual push-up doors, which may have the spring adjusting device inside the hood.

G. Brackets

1. Brackets shall close the ends of roller-shaft housing and shall support the hood. Ends of the roller shaft shall be journaled into bracket hubs. The shaft shall be fitted with self-lubricating, sintered bronze bearings or double sealed, grease lubricated ball bearings.

H. Hood

1. The hood shall be fabricated of at least 20 gage (0.032 inch) aluminum, shall be formed to fit the contours of the brackets, and shall be reinforced with rods, rolled beads, or a stiffening flange at top and bottom edges. Hoods at openings larger than 12 feet wide shall be fitted with intermediate supporting brackets. A flexible weather baffle, mounted internally or externally, shall be provided to prevent airflow around the coil, and provisions shall be included in the design of the hood to prevent the ingress of birds.

I. Locking Device

1. Manual push-up doors shall be fitted with a chain or bar type locking device designed to receive a padlock. For chain operated doors, provisions shall be made to secure the chain against travel by means of a padlock. Padlocks are covered under the finish hardware section.

J. Door Operation

1. Doors indicated on the Drawings to be manually operated shall be push-up type, fitted with one lifting handle on each side of the bottom rail and counterbalances. Manual doors more than 7 feet high shall be fitted with pulldown straps or pole hooks attached to the bottom rail. One pole shall be furnished for each door having pole hooks. Manual doors shall be counterbalanced and adjusted for easy operation, with a maximum pull of 35 lbs required for lift handle operation.

2. Doors indicated on the Drawings to be chain operated shall be provided with gear operators, with an endless chain operating over a sprocket and extending to within 2 feet of the floor. Reduction gearing shall be designed to reduce the pull required on the hand chain to a maximum of 35 lbs .

3. Doors indicated on the Drawings to be motor operated shall be provided with electric motor operators and auxiliary chain gear operation.

K. Finish

1. Curtain slats, hood, and bottom rails shall be given an anodic finish conforming to Aluminum Association (AA) requirements in the shop. Color will be selected from the manufacturer's standards, unless otherwise indicated on the Drawings. All other exposed metal parts of the door and accessories, except bearings and chains, shall be shop-primed.

2. Galvanizing shall comply with ASTM A653 for commercial steel sheets and ASTM A123 for assembled steel products. Galvanized surfaces shall be phosphatized before painting.

2.4 ELECTRIC MOTOR OPERATORS

1. Electric motor operators shall be of a type recommended by the door manufacturer and shall be complete with an electric motor, reduction gearing, magnetic brake, brackets, push-button controls, limit switches, magnetic reversing starters, and other accessories required for proper operation. Each operator shall be designed so that the motor may be removed without disturbing the limit switch adjustment and without affecting the emergency auxiliary operators. Provisions shall be made for immediate manual operation of the door in case of electric power failure. The emergency operating mechanism shall be arranged to be activated and deactivated from the floor, and its use shall not affect the adjustment of the limit switches. Whenever the mechanism is engaged, the motor shall be disconnected from the manual operating mechanism. Electric motor operators shall be wall-mounted near the head of the door, unless indicated on the Drawings.

B. Motors

1. Motors shall be of sufficient horsepower to move doors in either direction from any position at a rate between 0.5 foot and 1 foot per second when operating under full wind load conditions.

2. Motors shall be of open drip proof construction and rated 460 volts, 60 Hz, 3 phase.

C. Control System

1. Each door shall be equipped with an automatic control system arranged to control the opening, closing, and stopping of curtain travel, and to automatically reverse closing travel when the lower edge of the door curtain meets an obstruction. The control system shall be mounted in a NEMA Type 4 enclosure, or as indicated on the Drawings.

D. Motor Controller

1. The motor controller shall be a full voltage, reversing, magnetic type, with 480 volt, 60 Hz, 3 phase contactors; automatically reset thermal overload relays; 120 volt ac operating coils; and 480 to 120 volt dry-type control transformer complete with one secondary lead fused and the other secondary lead grounded. Starters shall not be smaller than NEMA Size 1.

2. Reversing starters shall be mechanically interlocked so that only one set of contacts can be closed at any one time.

3. Three thermal overload relays, rated to protect the motor from damage due to overload, shall be furnished with each motor starter.

4. The motor controller enclosure shall be sized and arranged to house the control power transformer and fuses, relays if required, and a marked terminal block on which all control wiring from all devices shall be terminated. The terminal block shall be located for easy installation and maintenance. All control wiring shall be 14 AWG or larger.

E. Control Switches

1. Remote control switches shall be located on the interior or exterior of the openings as indicated on the Drawings. Each switch control station shall be of the three-button, momentary contact type, with the buttons marked "Open", "Close", and "Stop". When the door is in motion and the "Stop" button is pressed, the door shall stop instantly and remain in the stopped position until the "Open" or "Close" button is pushed. Push buttons shall be of the fully guarded type to prevent accidental operation. Control switches located on the building exterior shall be mounted in NEMA Type 4 enclosures. Exterior control switches shall be provided with a key-operated locking device, unless indicated otherwise on the Drawings. Limit switches shall automatically stop the doors in their fully open and fully closed positions. The limit switches shall be readily adjustable.

F. Safety Device

1. The bottom edge of each electric motor operated door shall be equipped with a safety device, unless indicated otherwise on the Drawings, which will immediately stop the door upon contact with an obstruction in the door opening and reverse its downward travel. The safety device shall be connected with the "closed" limit switch to prevent opening a closed door by tripping the safety device. The safety device shall not serve as a substitute for a limit switch. Type S cable equipped with a spring-loaded automatic take-up reel, or an equivalent device, shall be provided between the safety device and the fixed cable supports.

G. Electrical Work

1. All manual or automatic control devices necessary for proper operation of the doors shall be provided. Motors and accessories shall be prewired at the factory to the extent practicable, with connections brought to terminal strips in the controller enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Doors shall be installed in accordance with details, drawings, and manufacturer's directions. All anchors and inserts for guides, brackets, motors, controls, switches, and other devices shall be accurately located. After installation, doors shall be free from warp, twist, or distortion, and shall be lubricated and properly adjusted to operate freely and smoothly.

3.2 CLEANING

A. After installation, factory finished metal surfaces shall be thoroughly cleaned and touched-up as recommended by the manufacturer. Abrasive, caustic, or acid cleaning agents shall not be used.

End of Section

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Section 08 45 00 - TRANSLUCENT WALL PANEL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the work necessary to furnish and install the translucent wall panels.

1.2 Related work specified elsewhere.

A. The requirements of the following sections and divisions apply to the work of this section:

1. Section 01 33 00 – Submittal Procedures
2. Section 01 65 00 – Product Delivery Requirements
3. Section 01 66 00 – Product Storage and Handling Requirements
4. Section 07 60 00 – Sheet Metal
5. Section 07 92 00 – Joint Sealants
6. Section 09 96 11 – Protective Coatings
7. Other sections of the Specification, not referenced above, shall also apply to the extent required for the proper performance of the Work.

1.3 GENERAL

A. Translucent Wall Panels

1. Translucent wall panels shall be constructed in accordance with the dimensions, arrangements, and materials indicated on the Drawings and specified herein, complete with all accessories and appurtenances indicated, specified, or required to give a complete weathertight unit.

    a. The items provided hereunder shall be the product of one manufacturer to achieve standardization for appearance, maintenance, and manufacturer's service.

1.4 SUBMITTALS

A. Before manufacturing of the unit is begun, the following drawings, certificates and samples shall be submitted in accordance with the Submittal Procedures section of the specification.

1. Shop Drawings. Submit shop drawings covering frame and panel conditions and complete anchorage details.

2. Color Selection Card. Manufacturer's standard color chart for aluminum frame finish.

3. Manufacturer's Certificate of Compliance. Submit manufacturer's certificate of compliance with performance criteria specified herein.

4. Erector's Affidavit. Submit erector's affidavit of qualification compliance.

5. Panel Sample. 6-inch square material sample.

B. Product Reports.

1. Submit product reports from ta qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.

a. Reports required are:
1) International Building Code Evaluation Report
2) Flame Spread and Smoke Developed (UL 723) – Submit UL Card
3) Color Difference (ASTM D2244)
4) Impact Strength (UL972)
5) Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
6) Bond Shear Strength (ASTM D 1002)
7) Beam Bending Strength (ASTM E 72)
8) NFRC System U-Factor Certification (NFRC 700)
9) Solar Heat Gain Coefficient (NFRC 700)
10) Condensation Resistance Factor (AAMA 1503)
11) Air Leakage (ASTM E 283)
12) 1200-degree F Fire Resistance (SWRI)
13) Performance for Windows (AAMA/WDMA/CSA-101/I.S.2/A440-05)
14) Daylight Autonomy

1.5 QUALITY ASSURANCE

A. Manufacturer's and Erector's Qualifications

1. Quality control inspections and testing shall be conducted at least once each year. Inspections and testing shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with "Acceptance Criteria for Sandwich Panels" as requested by the International Building Code or equivalent.

2. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of similar materials, for a period of at least 10 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 5 years or longer.

3. Erection shall be by an installer who has been in the business of erecting similar materials for at least 5 consecutive years; and can show evidence of satisfactory completion of projects of similar size, scope, and type.

B. Performance Requirement.

1. The manufacturer shall be responsible for the configuration and fabrication of the complete panel and frame system.

1.6 DELIVERY, STORAGE, AND HANDLIN.

A. Deliver, store, and handle translucent wall panel system in a manner to prevent damage, deterioration, and warping. Provide packaging such as cardboard or other containers, separators, banding, spreaders, and paper wrappings to protect all items.

B. Store translucent wall panel system units on long edge, upright, in a protected dry area, at least 6 inches or more off the ground or floor and at least 1/4 inch between individual pieces. Follow special storage and handling requirements of manufacturer. Protect exposed finish surfaces of prefinished items.

1.7 WARRANT.

A. Submit manufacturers and installer’s written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within five years of the date of delivery. Failure of materials or workmanship shall include leakage, excessive deflection, deterioration of finish on metal in excess of normal weathering and defects in accessories, insulated translucent sandwich panels and other components of the work.

B. In addition, there shall be a manufacturer’s 10-year Limited Warranty covering separation of faces from grid core, and/or abnormal color change of the exterior face.

C. There also shall be a manufacturer’s 20-year Limited Warranty against reinforcing fiber bloom.

1.8 ACCEPTABLE MANUFACTURER.

A. Acceptable manufacturers shall be as indicated in the individual sub-articles as specified in Part 2.

PART 2 - PRODUCTS

2.1 MANUFACTURE.

A. Products of the following manufacturer shall be used:

1. Kalwall Corporation, Manchester, New Hampshire.

2. Structures Unlimited, Inc., Manchester, New Hampshire.

3. Or approved equal.

2.2 MATERIALS AND PERFORMANCE CRITERI.

A. Framing Member.

1. Structural framework shall be tubular aluminum sized by manufacturer to support system. Related components to provide a complete system shall be aluminum shapes designed by the manufacturer and fabricated in strict accordance with shop drawings. The aluminum framing members shall be finished with a Kynar 500 coating or equal; color shall match window framing.

B. Translucent Face.

1. Translucent faces shall be manufactured by insulated panel system fabricator specifically for architectural use.

a. Flammability. The interior face sheet shall have a flame-spread rating no greater than 25 and smoke development no greater than 300 when tested in accordance with ASTM E84. Burn Extent by ASTM D635 shall be no greater than 1 inch.
b. Weatherability. The exterior face shall not change color more than 3.0 Adams Units (DELTA E by ASTM D2244) after 5 years outdoor weathering in South Florida at 7 degrees facing south, determined by the average of at least three samples. The face sheet shall not darken any more than 0.2 Adams Units (DELTA L by ASTM D2244) when exposed to 150°F, for 2 weeks. The exterior faces shall have high performance thermoset acrylic protective surface (minimum thickness 1.2 mils), for maximum resistance to erosion and weather, applied in the factory under controlled temperature conditions; the surfacing shall be fully field repairable and re-finishable if required.
c. Appearance. Kalwall panels shall be a white appearance at all locations. The white color for the wall panels shall be achieved by using “crystal” exterior sheets and white interior sheets. The face sheets shall be uniform in color to prevent splotchy appearance. Exterior face sheets shall be 0.070 inch thick. Interior face sheets shall be 0.045-inch thick. Faces shall not vary more than +10 percent in thickness. 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 and pinholes which collect moisture and dirt will not be acceptable.

d. Strength. The exterior face sheet shall be uniform in strength and repel an impact equal to 60 ft/lbs in accordance with SPI Shatter Resistance Test.

C. Adhesiv.

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". Minimum strength shall be:

a. 750 psi tensile strength by ASTM C297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D1037.
b. 500 psi shear strength average of five exposures by ASTM D1002:
1) 50 percent relative humidity at 73°F.
2) Accelerated aging by ASTM D1183.
3) 182°F.
4) Full cycle soak.
5) 500-hour oxygen bomb.

D. Grid Core

1. The aluminum I-beam shall be extruded 6063-T6, with provision for mechanical interlocking of muntin-mullion and perimeter to prevent high and low intersections which do not allow full bonding surface contact with face material. Width of I-beam shall be no less than 7/16 inch. Aluminum I-beam for the grid shall have complete surface contact with the skin material and shall have machined flanges to tolerances of not greater than ±0.002 inch. A welded or web interlocked grid core shall not be acceptable due to unevenness at muntin-mullion intersections.

E. Battens and Perimeter Closures

1. Extruded 6063-T5 or 6063-T6 aluminum screw clamp-tight closure system.

2. All battens and perimeter closures to be supplied with 300 Series stainless steel screws (excluding fasteners to the building). Aluminum battens and cap plates shall be field installed.

3. All exposed aluminum shall be corrosion resistant finish in color to be selected from manufacturer's standards.

F. Flexible Sealing Tape

1. Sealing tape shall be manufacturer's standard pre-applied to closure system at the factory under controlled conditions.

G. Fasteners

1. Fasteners to the building shall be stainless steel screws or bolts in expansion anchors of size as required to support system and as recommended by the manufacturer.

H. Isolation Paint

1. Bituminous coating as specified in the Protective Coatings section.

I. Ancillary Items

1. Provide miscellaneous flashings as required for a complete assembly; including required flashings for louvers installed within the translucent wall panel system.

2.3 PANEL CONSTRUCTION

A. Translucent panels in precast concrete wall shall have a thickness of 2-3/4 inches with a U-factor of .53 +/-; and light transmission of 30+/-.

B. Translucent panels shall be a true sandwich panel of flat fiberglass sheet 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.

C. Translucent sandwich panel deflection shall not exceed 3.5 inches at 35-pound per square foot loading and shall not exceed 0.10-inch set deflection 5 minutes after load release per ASTM E72 with a 12 feet clear span, tested flat.

D. Grid pattern shall be nominal 8 inch high by 12 inch wide by 24” high (Shoji) and symmetrical about the horizontal centerline of each panel, for flat 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 ensure bonding strength, white spots at intersections of muntins and mullions shall not exceed 4 of each 40 square feet of panel nor shall they be more than 3/64 inch in width.

F. Translucent panels and aluminum frame shall be preassembled where practical and sealed at the factory. Panels should be shipped to the jobsite in rugged shipping units and shall be ready for erection.

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall prepare the opening including isolating dissimilar materials from aluminum system which may cause damage by electrolysis.

3.2 ERECTION

A. The erector shall erect translucent panel system in strict accordance with shop drawings as supplied by manufacturer. Fastening and sealing shall be in strict accordance with manufacturer's shop drawings. All aluminum shall be cleaned before sealants are applied.

B. After other trades have completed work on adjacent material, carefully inspect translucent panel assembly and make adjustments necessary to insure proper installation and weathertight conditions.

C. All staging, lifts, and hoists required for the complete translucent system installation, including staging, etc., necessary for field measuring, shall be provided by, set up and maintained by the erector.

3.3 PROTECTION

A. After erection, the Contractor shall protect exposed portions from damage by machines, paint, acid cement, or other harmful compounds. The Contractor shall be responsible for removal of protective materials and cleaning with plain water, water with soap, household detergent, or as recommended by the manufacturer.

End of Section

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SECTION 08 70 00 - FINISH HARDWARE

PART 1 - GENERAL

1-1. SCOPE. This Section covers finish hardware for FRP doors.

1-2. GENERAL. Items included in this section shall conform with the following:

2021 International Building Code
NFPA 70, NFPA 80, NFPA 101
ANSI/BHMA Certified Product Standards – A156 Series

1-3. SUBMITTALS. Contractor shall submit a complete schedule of finish hardware in accordance with the requirements specified in the Submittals Procedures section. The schedule shall indicate each item of hardware required for each opening, manufacturer's name, manufacturer's number or symbol, and finish.

1-4. PACKAGING. Each item of hardware shall be packaged separately in an individual container complete with screws, keys, special wrenches, instructions, and installation templates necessary for accurately locating, setting, adjusting, and attaching the hardware. Each container shall be marked with the number of the opening to which the hardware item is to be applied.

1-5. COORDINATION.

A. 1-5.01. Templates. Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. 1-5.02. Door and Frame Preparation. Related Division 08 section FRP Doors and Frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1-6. WARRANTY.

A. 1-6.01. General Warranty. Special warranties specified in this Article 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.

B. 1-6.02. Warranty Period. Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.

2. Faulty operation of the hardware.

3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

A. 1-6.03. Standard Warranty Period. Three years from date of Substantial Completion, unless otherwise indicated.

B. 1-6.04. Special Warranty Periods.

1. Seven years for heavy duty cylindrical (bored) locks and latches.

2. Five years for exit hardware.

3. Ten years for manual door closers.

PART 2 - PRODUCTS

2-1. ACCEPTABLE MANUFACTURERS. The catalog numbers which appear in the Hardware Schedule identify products of the listed manufacturers herein for each hardware item. Equivalent products of the other manufacturers listed herein will also be acceptable.

Hinges	McKinney, Hager, Stanley
Locksets, Latchsets, and Cylinders	Sargent, Yale, Corbin Russwin
Exit Devices	Sargent, Yale, Corbin Russwin, Von Duprin
Closers	Sargent, Norton, LCN, Corbin Russwin
Thresholds, Cast Abrasive	Pemko, Wooster, American Abrasive or Stubbs.
Drip Caps, Extruded	Pemko, Reese, Zero
Gasketing/Weatherstripping	Pemko, Reese, Zero
Kick Plates, Surface Bolts, Overhead Holds, Bumpers, and Silencers	Rockwood, McKinney, Ives

2-2. FINISH. The required finish shall be as indicated by the catalog number listed in the Hardware Schedule herein. Exterior surfaces of door closers shall be finish painted with shop-applied powder coated finish, plated finishes, or special coatings as indicated in the

schedule. Machine screws, bolts, and other exposed attachments shall be finished to match hardware.

2-3. KEYING. All cylinder locks shall be keyed in groups. All cylinders shall be furnished with interchangeable cores. After the finish hardware submittals have been accepted by the Engineer, the Owner will meet with the Contractor and the hardware consultant to determine the keying groups. All locks in each group shall be keyed alike and each group shall be keyed differently. Two "Do Not Duplicate" keys shall be provided with each lock where required by the Owner.

PART 3 - EXECUTION

3-1. INSTALLATION. Hardware shall be accurately fitted, securely applied, carefully adjusted, and lubricated in accordance with the manufacturer's instructions.

A. 3-1.01. Location. Unless otherwise directed by the Engineer, the locations of hardware items shall be in accordance with DHI "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames".

B. 3-1.02. Thresholds. The ends of thresholds shall be notched to fit the applicable door frame profile. Thresholds shall be field drilled to receive flush bolts where required. Thresholds shall be anchored to concrete by means of 5/16-inch diameter stainless steel flat head countersunk machine screws and expansion anchors spaced at 8-inch centers. Thresholds shall be set in asphalt roofing cement conforming to ASTM D4586, Type II.

3-2. ADJUSTING. Each supplier of finish hardware shall provide the services of a trained and experienced hardware consultant to service and adjust installed hardware.

3-3. PROTECTION. Special care shall be taken to protect finished surfaces of hardware during installation. Hardware on which the finish has been damaged prior to final acceptance of the work shall be replaced with new hardware at no additional cost to the Owner.

3-4. HARDWARE SCHEDULE. Hardware shall be furnished in accordance with the following schedule. Doors are listed by group number. A complete set of hardware is listed for each group, as follows:

Set #1 *(Exterior, Pair 3'-0" x 7'-2", Locked, Panic)*
Door 101B, 102A, 103B, 104

Item	# Req'd	Catalog No.	Finish	Manufacturer
Hinges	6	T4A3386 4-1/2x4-1/2 NRPxSSF	32D	McKinney
Exit Device	1	8713 x ETL (surface vertical rod)	630	Sargent
Closer	1	351 CPSH	EN	Sargent
Threshold	1	252X2-A-FG		Pemko
Gasketing	2 sets	2891AS head & 290AS jamb		Pemko

Raindrip	1	346 C		Pemko
Bottom Sweep	2	315CN		Pemko
Surface Bolts	2	585-12	US26D	Rockwood
Overhead Hold	1	19000 Series	US32D	Rockwood
Install surface bolts and overhead hold on inactive leaf, closer and exit device on active leaf. Flat bar astragal on active leaf by door manufacturer.				
Set #2 *(Exterior, 3'-0" x 7'-2", Locked, Panic)* *Doors 101C, & 103A*				
Item	**# Req'd**	**Catalog No.**	**Finish**	**Manufacturer**
Hinges	3	T4A3386 4-1/2x4-1/2 NRPxSSF	32D	McKinney
Exit Device	1	8813 x ETL (rim device)	630	Sargent
Closer	1	351 CPSH	EN	Sargent
Threshold	1	252X2-A-FG		Pemko
Gasketing	1 set	2891AS head & 290AS jamb		Pemko
Raindrip	1	346 C		Pemko
Bottom Sweep	1	315CN		Pemko

End of Section

SECTION 08 90 00 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of stationary type weather louvers,. Combination louver/dampers, control dampers, fire dampers, adjustable louvers, penthouses, and smoke vents are covered in other sections.

1.2 GENERAL

A. Louvers shall be furnished and installed as specified herein and in accordance with the details, louver schedule, or arrangements indicated on the Drawings.

B. Louvers shall be of the sizes required for opening sizes indicated on the Drawings. Actual opening sizes for louvers scheduled for insertion within existing construction shall be field verified. Actual louver sizes shall allow for shim and caulk space.

1.3 SUBMITTALS

A. Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers shall be submitted in accordance with the Submittals Procedures section.

1.4 COLOR SELECTION

A. Colors of louvers will be selected from the manufacturer’s full line of colors by Engineer. Procedures for selecting colors shall be as indicated in the Submittals Procedures section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground and protected from the weather.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Governing Standard

1. Except as modified or supplemented herein, all stationary louvers shall be certified to meet the performance criteria specified and outlined by AMCA Standard 500.

B. Finishes

1. Louvers shall have a **70% Kynar paint finish meeting AAMA specification 2605-11 with 1.2 mils total dry film thickness.**

2. 70% Kynar paint finishes shall meet the AAMA specification 2605-11 with 1.2 mils total dry film thickness. 50**%** Kynar paint finishes shall meet the AAMA specification 2604-05 with 1.2 mils (50% Kynar has a much larger standard color selection.)

3. Clear anodized finishes shall meet the standards of the Aluminum Association AA-C22A41 with 0.7 mils surface depth treatment.

C. Construction

1. Louvers shall be of aluminum construction and shall be the product of one manufacturer. Louvers shall be furnished complete with all hardware and appurtenances necessary for a satisfactory installation. The louvers shall have extended sills as shown on the Drawings. The louvers shall be welded construction.

2. Stationary type weather louvers shall be architectural style continuous blades with concealed mullions.

D. Performance Requirements

1. Stationary Type

a. The velocity at which the beginning point of water penetration occurs for stationary type weather louvers shall be at least 790 fpm . The minimum free area for a 48 inches x 48 inches louver shall be 54 percent. The maximum static pressure loss at 600 fpm shall be 0.08 inches wc.

2.2 ACCEPTABLE PRODUCTS

A. Stationary Type Weather Louvers

1. Subject to the requirements specified herein, stationary type weather louvers shall be equivalent to the following:

Ruskin “ELF-375XH”

Arrow United Industries “EA-410”

B. Acoustical Louvers

1. Subject to the requirements specified herein, 6 inch deep acoustical louvers shall be equivalent to the following:

Ruskin “EAL6811”

American Warming and Ventilating “LAA-66”

C. Brick Vents

1. Subject to the requirements specified herein, brick vents shall be equivalent to the following:

American Warming and Ventilating “BV”

Arrow United Industries “Extruded Aluminum Brick Vents”

Ruskin “BV100”

D. Accessories

1. Stationary type louvers shall have aluminum removable bird screens.

2. Brick vents shall have aluminum insect screens.

2.3 Materials

Aluminum Extrusions	ASTM B221, Alloy 6063-T5, minimum 0.125 inch thick.
Bird Screen	0.051 inch expanded, 0.50 inch flattened bird screen.

PART 3 - EXECUTION

3.1 GENERAL

A. Products shall be installed in accordance with this section, the manufacturer’s instructions, and as indicated on the Drawings.

B. Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers and vents will be made available to the louver and vent installer.

3.2 INSTALLATION

A. The louvers shall be installed with anchors suitable for the adjacent material and shall be caulked as specified in the caulking section. When required, bird screens or insect screens shall be installed on the louvers.

B. Where aluminum work is to be attached to steel supporting members or other dissimilar metal, the aluminum shall be kept from direct contact with such metals by a heavy coat of epoxy enamel in accordance with the Architectural Painting section. Aluminum surfaces which will be in contact with concrete or masonry when installed shall be given a heavy coat of epoxy enamel. All paint shall be dry and hard when the coated parts are installed.

End of Section

SECTION 09 96 11 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers field applied protective coatings, including surface preparation, protection of surfaces, inspection, and other appurtenant work for equipment and surfaces designated to be coated with heavy-duty maintenance coatings. Regardless of the number of coats previously applied, at least two field coats in addition to any shop coats or field prime coats shall be applied to all surfaces unless otherwise specified.

1.2 GENERAL

A. Cleaning, surface preparation, coating application, and thickness shall be as specified herein and shall meet or exceed the coating manufacturer's recommendations. When the manufacturer's minimum recommendations exceed the specified requirements, Contractor shall comply with the manufacturer's minimum recommendations. When equivalent products are acceptable to Engineer, Contractor shall comply with this Specification and the coating manufacturer's recommendations.

B. Governing Standards

1. All cleaning, surface preparation, coating application, thickness, testing, and coating materials (where available) shall be in accordance with the referenced standards of the following AWWA, ANSI, NACE, SSPC, NSF, and ASTM.

C. Delivery and Storage

1. All coating products shall be received and stored in accordance with the coating manufacturer's recommendations.

D. Coatings, Painting, and Linings Covered in Other Sections

1. Corrosion protection lining systems for secondary containment.

2. Elastomeric high solids urethane lining systems for corrosion protection and waterproofing.

1.3 SUBMITTALS

A. General Submittals and Data

1. Contractor shall submit color cards for all coatings proposed for use, together with complete descriptive specifications, manufacturer's product data sheet and the completed Coating System Data Sheets, to Engineer for review and color selection. Each product data sheet shall include application temperature limits including recoat time requirements for the ambient conditions at the site, including temperatures up to 130° F . Requests for review submitted directly to Engineer by coating suppliers will not be considered.

B. NSF 61 and NSF 600 Compliance

1. When the proposed products will be in contact with treated or raw water in potable water treatment facilities, Contractor shall submit certifications that the proposed systems are in compliance with ANSI/NSF 61 and ANSI/NSF 600.

C. Data Sheets

1. Contractor shall submit a Coating System Data Sheet for each separately identified surface in the Metal Surfaces Coating Schedule, Concrete and Masonry Surfaces Coating Schedule, and the Miscellaneous Surfaces Coating Schedule that will be used in the Project, using the appropriate Coating System Data Sheet forms (Figures 1- 09 96 11 and 2- 09 96 11) at the end of this section. Each field coating system shall be acceptable to the coating material manufacturer.

a. Coating System Data Sheets shall be assigned a unique number with a prefix letter based on the following:

Prefix	Surfaces	Fig. 09 96 11
A	Iron and steel (coated entirely in field)	1
A	Iron and steel (shop primed)	2
C	Concrete and concrete block	1
E	Equipment - submerged	1
E	Equipment – nonsubmerged	2
F	Nonferrous metal	1
G	Galvanized	1
H	High temperature	1
P	PVC and FRP	1

b. Each coating system that will be applied entirely in the field shall be assigned only a prefix letter and no suffix letter. Fig 1- 09 96 11 shall be submitted for each surface coated entirely in the field.

c. Each shop-applied coating system that includes one or more field applied coats shall be assigned both a prefix letter and suffix letter "F." Fig 2- 09 96 11 shall be submitted for each surface having a shop applied coating and one or more field applied finish coats.

d. A separate Coating System Data Sheet shall be developed and submitted for each surface scheduled to be coated or variation or change in a coating system. The

number identifying the surface and coating system shall be of the form $A1_1$ or $A1_2$-F. The subscript number shall be assigned by the Contractor so that each surface and coating system combination is uniquely identified. For example:

1) $A1_1$-F may be assigned to "Epoxy – one coat to metal curbs for skylights and power roof ventilators that have been shop primed."
2) $A2_1$ may be assigned to "Epoxy – two coats to non-galvanized structural and miscellaneous steel exposed to view inside buildings."
3) $C2_1$ may be assigned to "Epoxy – two coats to all concrete and concrete block in corrosive area (Except floors and surfaces scheduled to receive other coatings) which are exposed to view."
4) $C2_2$ may be assigned to "Epoxy – two coats to walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment as indicated on the Drawings."

D. Color Submittals

1. The manufacturer's standard colors will be acceptable for all coatings.

1.4 QUALITY ASSURANCE

A. Coating System Data Sheet Certifications

1. The coating applicator and coating manufacturer shall review and approve in writing the coating manufacturer's written recommendations for the coating system and the intended service. Any variations from the Specifications or the coating manufacturers published recommendations shall be submitted in writing and approved by the coating manufacturer.

2. The coating manufacturer shall observe the surface preparation, mixing, and application of the coating systems and submit a written report of his observations and any additional recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Alternative Manufacturers

1. In addition to the coatings listed herein, equivalent products of other manufacturers that distribute globally will also be acceptable.

B. Equivalent Coatings

1. Whenever a coating is specified by the name of a proprietary product or of a particular manufacturer or vendor, it shall be understood as establishing the desired type and quality of coating. Other manufacturers' coatings will be accepted, provided that sufficient information is submitted to enable Engineer to determine that the proposed coatings are

equivalent to those named. Information on proposed coatings shall be submitted for review in accordance with the Submittals Procedures section. Requests for review of equivalency will be accepted only from Contractor and will be considered only after the contract has been awarded.

2.2 MATERIALS

A. All coatings shall be delivered to the job in original, unopened containers, with labels intact. Coatings shall be stored indoors and shall be protected against freezing. No adulterant, unauthorized thinner, or other material not included in the coating formulation shall be added to the coating for any purpose.

B. All coatings shall conform to the air quality regulations applicable at the location of use. Coating materials that cannot be guaranteed by the manufacturer to conform, whether or not specified by product designation, shall not be used.

C. With the exception of heat resistant coatings, the coatings specified have been selected on the basis of the manufacturer's statement that the VOC content of the product is 2.8 lbs per gallon or less; however, it shall be the Contractor's responsibility to use only coating materials that are in compliance with the requirements of all regulatory agencies. Local regulations may require some coatings to have a lower VOC content than specified herein. The coatings specified may meet the VOC limits in the unthinned (as shipped) condition but may exceed the limits if thinned according to the manufacturer's recommendations. In such case, the coatings shall not be thinned beyond the 2.8 lbs per gallon limit, and if the product cannot be thinned to suit the application method or temperature limits, another manufacturer's coating shall be used, subject to acceptance by Engineer's coating shall be used, subject to acceptance by Engineer.

D. Contractor shall be responsible for ensuring the compatibility of field coatings with each other or with any previously applied coatings. Coatings used in successive field coats shall be produced by the same manufacturer. The first field coat over shop coated or previously coated surfaces shall cause no wrinkling, lifting, or other damage to underlying coats.

E. Primers

Universal Primer (tie coat)	PPG "Amerlock Sealer," Carboline "Rustbond Series," International Devoe "Devran 201H," Tnemec "Series 27 F.C. Typoxy," or Sherwin-Williams "Dura Plate 235."
Zinc Primer	PPG "Dimetate 9 Series," Carboline "Carbo Zinc II Series," International Devoe "Catha-Coat 302H," Tnemec «Series 90-97 Zinc Primer », or Sherwin-Williams "Zinc Clad II Series."

F. Fillers and Surfacers

Epoxy Concrete Block Filler	PPG "Amerlock 400BF Epoxy Block Filler," Carboline "Sanitile 600," International Devoe "Devron 224V," Tnemec " Series 130 Envirofill ," or Sherwin-Williams " "

Epoxy Concrete Filler and Surfacer	Tnemec “Series 218 MortarClad,” PPG Amercoat “ 114A,” Carboline “Carboguard 510,” or Sherwin-Williams “Steel Seam FT910.”

G. Intermediate and Finish Coatings

Epoxy (NSF 61 and NSF 600 certified systems)	
Ferrous Metal Surfaces and Concrete Surfaces in Contact with Treated or Raw Water in Potable Water Facilities	PPG “Amerlock 400 High-Solids Epoxy Coating,” Carboline “Carboguard 891 VOC,” International Devoe “Bar-Rust 233H” Tnemec “Series L140 Pota-Pox Plus,” or Sherwin-Williams “Dura Plate 235 NSF”; immersion service.
Epoxy	
Concrete Floors	PPG “Amerlock 2/400,” Carboline “Carboguard 890,” International Devoe “Devran 224V,” Tnemec “Series N69 Hi-Build Epoxoline II,” or Sherwin-Williams “Armorseal 1000HS”; nonskid.
Ferrous Metal Surfaces and Masonry or Concrete Surfaces Other Than Floors	PPG “Amercoat 385 Epoxy,” Carboline “Carboguard 890,” International Devoe Devran “224V,” Tnemec “Series N69 Hi-Build Epoxoline II,” or Sherwin-Williams “Dura Plate 235.”
Flake-Filled Epoxy	PPG Novaguard 890 FF, Carboline “Plasite 4500/4500S,” Sherwin-Williams “Sher-Glass FF,”, Tnemec “Series 142 Epoxoline.” or International “Interzone 954GF”.
Aliphatic Polyurethane	PPG “Pitthane Ultra,” Carboline “Carbothane 134HG,” International “Intervane 990V” Tnemec “Series 1074 Endura-Shield II,” or Sherwin-Williams “Acrolon 218HS.”
Coal Tar Epoxy/ High-build coal tar epoxy	PPG Amercoat “78HB Coal Tar Epoxy,” Carboline “Bitumastic 300 M,” Tnemec “46H-413 Hi-Build Tneme-Tar,” International “Interzone 954 Black" or Sherwin-Williams “Targuard Coal Tar Epoxy”
Medium Consistency Coal Tar	PPG Amercoat 240 Black, Carboline “Bitumastic 50” International “Devoe Bar-Rust 236 Black” or Tnemec “46-465 H.B. Tnemecol.”
Vinyl Ester	Tnemec “Series 120 Vinester” Carboline “Plasite 4110” or Sherwin-Williams “Magnalux 304FF.” International Paint «Ceilcote 232 Flakeline »

Heat-Resistant (Suitable for temperatures up to 400° F [207° C]	PPG “Hi Temp 500,” Carboline “Thermaline 450,” Tnemec “43-36 Chrome Aluminum,” International “Interbond 2340UPC” or Sherwin-Williams “Heat-Flex Hi-Temp 500.”
High Heat-Resistant (Suitable for temperatures up to 1000° F [537° C]	PPG “Hi Temp 1000,” Carboline “Thermaline 4700 VOC,” or Sherwin-Williams “Heat-Flex Hi-Temp 1000.”
Acrylic Latex Emulsion (Flat)	PPG “Pitt Tech Series”, Carboline “Carbocrylic 3359”, International “Intercryl 520 Waterborne Acrylic” or Tnemec “Series 1026 Enduratone”.
Acrylic Latex Emulsion (semi-gloss)	PPG “Pitt Tech Series”, Carboline “Carbocrylic 3359”, Sherwin-Williams “SherCryl HPA Semi-Gloss”, or Tnemec “Series 1029 Enduratone”.
Acrylic Latex Emulsion (Gloss)	PPG “Pitt Tech Series”, Carboline “Carbocrylic 3359”, Sherwin-Williams “SherCryl HPA Gloss”, International “Intercryl 530 Waterborne Acrylic” or Tnemec “Series 1028 Enduratone”.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. All surfaces to be coated shall be clean and dry and shall meet the recommendations of the coating manufacturer for surface preparation. Freshly coated surfaces shall be protected from dust and other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss on previously coated surfaces shall be dulled if necessary for proper adhesion of topcoats.

B. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film, except for concrete block construction where a rough surface is an inherent characteristic.

C. When applying touchup coating or repairing previously coated surfaces, the surfaces to be coated shall be cleaned as recommended by the coating manufacturer, and the edges of the repaired area shall be feathered by sanding or wire brushing to produce a smooth transition that will not be noticeable after the coating is applied. All coatings made brittle or otherwise damaged by heat of welding shall be completely removed.

D. Galvanized Surfaces

1. When a coating is required, galvanized surfaces shall be prepared for coating according to the instructions of the manufacturer of the epoxy. Any chemical treatment of galvanized surfaces shall be followed by thorough rinsing with clean water.

E. Ferrous Metal Surfaces

1. Ungalvanized ferrous metal surfaces shall be prepared for coating by using one or more of the following cleaning procedures specified here-in: solvents (SSPCSP1); abrasive blasting (SSPC-SP5, -SP10, -SP6, or -SP7) power tools (SSPCSP3 or -SP11); or hand tools (SSPCSP2). Oil and grease shall be completely removed in accordance with SSPCSP1 before beginning any other cleaning method. Surfaces of welds shall be scraped and ground as necessary to remove all slag and weld spatter. Tools which produce excessive roughness shall not be used.

2. All components of equipment that can be properly prepared and coated after installation shall be installed prior to surface preparation. Components that will be inaccessible after installation shall have the surfaces prepared and coated before installation. Motors, drive trains, and bearings shall be protected during surface preparation in accordance with the equipment manufacturer's recommendations.

3. All cut or sheared edges shall be ground smooth to a 1/8 inch minimum radius for all material 1/4 inch thickness and larger. For material thickness less than 1/4 inch all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of the 1/16 inch will not be required.

4. All ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard SP0178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as required by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory adhesion of paint.

5. The cleaning methods and surface profiles specified herein are minimums, and if the requirements printed in the coating manufacturer's data sheets exceed the limits specified, the value printed on the data sheets shall become the minimum requirement.

6. Ferrous Metal Surfaces – Non-immersion Service

   a. Ferrous metal surfaces, including fabricated equipment, in non-immersion service shall be cleaned to the degree recommended by the coating manufacturer for surfaces to be coated with coal tar epoxy, epoxy, and heat-resistant coatings, except galvanized surfaces. Surface preparation of ferrous metal surfaces in non-immersion service shall consist of abrasive blast cleaning to SSPC-SP6, and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 2.0 mils .

7. Ferrous Metal Surfaces - Immersion Service

   a. Surface preparation of ferrous metal surfaces in immersion service shall consist of abrasive blast cleaning to at least SSPC-SP10 and the first application of coating

shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 3.5 mils .

F. Concrete Surfaces

1. All concrete surfaces shall be free of objectionable substances and shall meet the coating manufacturer's recommendations for surface preparation. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6. Any other surface preparation recommended by the coating material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

2. All concrete surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, and other objectionable substances. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started.

3. New concrete shall have sufficiently cured for at least 4 weeks or reached moisture content levels at or below the material manufacturer's requirements before coating is applied. Concrete surfaces shall be tested for capillary moisture in accordance with ASTM D4263. There shall be no capillary moisture when coatings are applied on concrete.

4. All surfaces to be coated shall be cleaned and prepared in accordance with the printed manufacturer's requirements or ASTM D4258 and abraded in accordance with ASTM D4259. Surface profile shall be at least 25 percent of the dry film thickness specified for the coating system. Prior to application of the coating, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. Spalled areas, voids, and cracks shall be repaired in accordance with the Concrete section and as acceptable to the Engineer. Fins and other surface projections shall be removed to provide a flush surface before application of coating.

5. Except where epoxy is applied as damp-proofing, the concrete surfaces, including those with bug holes less than 1 inch in any dimension, shall be prepared as recommended by the manufacturer, using an epoxy concrete filler and surfacer. Where coating with a vinyl ester the concrete filler and surfacer shall be as recommended by the manufacturer to be compatible with vinyl ester.

G. Concrete Block Surfaces

1. Voids and openings in concrete block surfaces shall be pointed. All exposed exterior surfaces and surfaces to be coated with epoxy, including the joints, shall be filled so that a continuous unbroken coating film is obtained.

H. Copper Tubing

1. All flux residue shall be removed from joints in copper tubing. Immediately before coating is started, tubing shall be wiped with a clean rag soaked in xylol.

I. Plastic Surfaces

1. All wax and oil shall be removed from plastic surfaces that are to be coated, including PVC and FRP, by wiping with a solvent compatible with the specified coating.

J. Hardware

1. Hardware items such as bolts, screws, washers, springs, and grease fittings need not be cleaned prior to coating if there is no evidence of dirt, corrosion, or foreign material.

K. Aluminum

1. When a coating system is required, remove all oil or deleterious substance with neutral detergent or emulsion cleaner or blast lightly with fine abrasive.

L. Stainless Steel

1. When a coating system is required, surface preparation shall conform to the coating manufacturer's recommendations.

M. Existing Coated Surfaces.

1. Existing surfaces which are anticipated to be modified or disturbed by the Work have been tested for lead and chromium and the results are presented in the existing Hazardous Environmental Condition report identified in the Supplemental Conditions. Some surfaces tested positive for lead and chromium. As indicated in the Project Requirements section, Contractor shall abate all paint, protective coatings, and linings containing detectable quantities of lead, chromium, or other heavy metals that are in areas potentially impacted, damaged, or disturbed during execution of the Work.

2. Existing Piping. Testing of the existing coatings on existing piping to be coated shall be conducted to determine adhesion capability and compatibility with the coatings specified herein. Existing coatings on piping shall be checked and prepared as recommended by the coating manufacturer and topcoated with the specified coatings. If necessary, existing coatings shall be removed to bare substrate. The piping shall be cleaned, primed, and coated as specified.

3. Existing Concrete and Concrete Block Surfaces. Existing concrete and concrete block surfaces which have been coated shall be prepared in accordance with ASTM D4261 and ASTM D4258 and the coating manufacturer's recommendations.

4. Existing Equipment Surfaces. Existing surfaces of equipment that is modified shall be prepared as indicated above for non-immersion or immersion service as applicable.

3.2 Other Existing Coated Surfaces. Other existing coated surfaces which are indicated on the drawings to be recoated shall be prepared in accordance with the coating manufacturer's recommendations.

3.3 MIXING AND THINNING

A. Coating shall be thoroughly mixed each time any is withdrawn from the container. Coating containers shall be kept tightly closed except while coating is being withdrawn.

B. Coating shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied coating be reduced, by addition of coating thinner or otherwise, below the thickness recommended by the coating manufacturer. Thinning shall be done in compliance with all applicable air quality regulations.

3.4 APPLICATION

A. Coating shall be applied in a neat manner that will produce an even film of uniform and proper thickness, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be thoroughly dry and hard before the next coat is applied. Each coat shall be a different color, if available. In no case shall coating be applied at a rate of coverage greater than the maximum rate recommended by the coating manufacturer.

B. Coating failures will not be accepted and shall be entirely removed down to the substrate and the surface recoated. Failures include but are not limited to sags, checking, cracking, teardrops, fat edges, fisheyes, or delamination.

C. Priming

1. Edges, corners, crevices, welds, and bolts shall be given a brush coat (stripe coat) of primer before application of the primer coat. The stripe coat shall be applied by a brush and worked in both directions. Special attention shall be given to filling all crevices with coating. When using zinc primers the stripe coat shall follow the initial prime coat.

2. Abraded and otherwise damaged portions of shop-applied coating shall be cleaned and recoated as recommended by the manufacturer of the finish coating. Welded seams and other uncoated surfaces, heads and nuts of field-installed bolts, and surfaces where coating has been damaged by heat shall be given a brush coat of the specified primer. Before the specified spot or touchup coating of metal surfaces, edges, corners, crevices, welds, and bolts in the area of the spot or touchup coating shall be given a brush coat of primer. This patch, spot, or touchup coating shall be completed, and the paint film shall be dry and hard, before additional coating is applied.

D. Epoxy

1. When used, epoxy shall be applied in accordance with the coating manufacturer's recommendations, including temperature limitations and protection from sunlight until top-coated.

2. When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

3. When applying high build epoxy coatings with a roller or brush and where a dry film thickness of at least 4-6 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

E. Coal Tar Epoxy

1. When used, the application of coal tar epoxy, including time limits for recoating, shall conform to the recommendations of the coating manufacturer.

2. When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

F. Vinyl Ester

1. When used, the application of vinyl ester coating system, including time limits for recoating and temperature requirements of the materials, shall conform to the recommendations of the coating manufacturer.

G. Film Thickness

1. The total coating film thickness including intermediate coats and finish coat, shall be not less than the following:

Type of Coating	Minimum Dry Film Thickness
Medium consistency coal tar	20 mils .
Coal tar epoxy (two coats)	20 mils .
Epoxy	
Floors (two coats)	10 mils .
Surfaces with first coat of epoxy and final coat of aliphatic polyurethane	7 mils (5 mils DFT for epoxy plus 2 mils DFT for aliphatic polyurethane).
Surfaces with first and second coat of epoxy and final coat of aliphatic polyurethane	12 mils (10 mils DFT for epoxy plus 2 mils DFT for aliphatic polyurethane).
Other surfaces (two coats)	10 mils .
Immersion service (three coats)	15 mils .
Flake-filled epoxy (two coats)	30 mils .

Type of Coating	Minimum Dry Film Thickness
Vinyl ester	30 mils .
Zinc, epoxy, polyurethane	
Surfaces with first coat of zinc, intermediate coat of epoxy, and final coat of aliphatic polyurethane	10 mils , 3 mils zinc, 5 mils epoxy, plus 2 mils for aliphatic polyurethane.
Heat-resistant (silicone)	3 mils .
High heat-resistant (silicone)	3 mils .
Other (one coat)	5 mils .
Other (two coats)	10 mils .

H. Weather Conditions

1. Coatings shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied coating.

2. Coatings shall not be applied at temperatures lower than the minimum temperature recommended by the coating manufacturer, or to metal surfaces such as tanks or pipe containing cold water, regardless of the air temperature, when metal conditions are likely to cause condensation. When necessary for proper application, a temporary enclosure shall be erected and kept heated until the coating has fully cured.

3. Coatings shall not be applied at temperatures higher than the maximum temperature recommended by the coating manufacturer. Where coatings are applied during periods of elevated ambient temperatures, Contractor and the coatings manufacturer shall be jointly responsible to ensure that proper application is performed including adherence to all re-coat window requirements. Precautions shall be taken to reduce the temperature of the surface application, especially for metal, at elevated temperatures above 100° F including shading application area from direct sunlight, applying coating in the evening or at night, and ventilating the area to reduce the humidity and temperature,

4. Vinyl ester coating materials, when required, shall be maintained during transportation, storage, mixing, and application at the temperature required by the coating manufacturer, 35° F to 90° F .

3.5 REPAIRING FACTORY FINISHED SURFACES

A. Factory finished surfaces damaged prior to acceptance by Owner shall be spot primed and recoated with materials equivalent to the original coatings. If, in the opinion of Engineer, spot repair of the damaged area is not satisfactory, the entire surface or item shall be recoated.

3.6 PROTECTION OF SURFACES

A. Throughout the work Contractor shall use drop cloths, masking tape, and other suitable measures to protect adjacent surfaces. Contractor shall be responsible for correcting and repairing any damage resulting from its or its subcontractors' operations. Coatings spilled or spattered on adjacent surfaces which are not being coated at the time shall be immediately removed. Exposed concrete or masonry not specified to be coated which is damaged by coatings shall be either removed and rebuilt or, where authorized by Owner, coated with two coats of masonry coating.

3.7 FIELD QUALITY CONTROL

A. The following inspection and testing shall be performed: surface profile, visual inspection, spark testing, adhesion testing, and wet and dry film thickness testing. All inspection and testing shall be witnessed by Engineer.

B. Surface Profile Testing

1. The surface profile for ferrous metal surfaces shall be measured for compliance with the specified minimum profile. The surface profile for concrete shall comply with SSPC 13/NACE 6 Table 1 for severe service.

C. Visual Inspection

1. The surface of the protective coatings shall be visually inspected.

D. Film Thickness

1. Coating film thickness shall be verified by measuring the film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil . Dry film thickness shall be measured in accordance with SSPC-PA 2.

E. Spark Testing

1. Coatings shall be spark tested by the coating manufacturer using an acceptable electrical spark tester set at the recommended voltage. Engineer shall observe the spark testing and shall verify the testing equipment is working properly before the spark testing of the coating is started. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 110 percent of the coated surface.

2. Spark testing for coatings on metal shall be done in accordance with ASTM D5162. Spark testing for coating on concrete shall be done in accordance with ASTM D4787.

3. All detected holidays and pinholes shall be marked and repaired as recommended by the coating material manufacturer.

F. Adhesion Testing

1. An adhesion test shall be conducted on properly prepared and coated steel or concrete surface that is acceptable to the coating material manufacturer and Engineer. The test area shall be at least 2 square feet [0.2 m^2] or larger to allow a minimum of three tests to be conducted. The test area shall then be coated with the specified system and cured as recommended by the coating material manufacturer.

2. At the Engineer/Owner's discretion, pull-off strength adhesion tests of the coating shall be conducted by the coating material manufacturer in accordance with ASTM D4541 for metal surfaces and ASTM D7234 for concrete surfaces. Elcometer or other tensile adhesion tester acceptable to the Engineer shall be used. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength recommended by the coating material manufacturer and shall exceed the tensile strength of the concrete.

3. If the coating fails the adhesion test, the cause of the failure shall be determined and corrected before reconducting the test.

3.8 FIELD PRIMING SCHEDULE

A. In general, steel and cast iron surfaces of equipment are specified to be shop primed. Any such surfaces which have not been shop primed shall be field primed. Damaged or failed shop coatings which have been determined unsuitable by Engineer shall be removed and the surfaces shall be field coated, including prime coat (if any). Galvanized, aluminum, stainless steel, and insulated surfaces shall be field primed. Primers used for field priming, unless otherwise required for repair of shop primers, shall be:

Surface To Be Primed	Material
Equipment, surfaces to be coated with	
Aliphatic polyurethane	Universal primer.
Epoxy	Same as finish coats.
Coal tar coating	Same as finish coats.
Vinyl ester	Same as finish coats.
Steel and cast iron, surfaces to be coated with	
Epoxy	Same as finish coats or inorganic zinc.
Coal tar coating	Same as finish coats.
Aluminum	Epoxy.
Galvanized	Epoxy.
Copper	Epoxy.
Stainless steel	Epoxy.
Plastic surfaces, including PVC and FRP	Same as finish coats.
Insulated steel or cast iron piping	Universal primer.

Surface To Be Primed	Material
Piping Insulation	As Recommended by manufacturer of finish coats.
Concrete, surfaces to be coated with epoxy	
For damp-proofing	Epoxy.
For all other surfaces	Epoxy concrete filler and surfacer.
Concrete block exposed in exterior locations	Epoxy concrete block filler.
Concrete block to be coated with epoxy	Epoxy concrete block filler.

B. Unless otherwise recommended by the coating manufacturer or specified herein, priming will not be required on concrete, or concrete block, nor on metal surfaces specified to be coated with coal tar epoxy, and heat-resistant coatings. Concrete surfaces to be coated with epoxy shall be filled with epoxy concrete filler and surfacer so that a continuous film is obtained, except where concrete is damp-proofed with epoxy.

3.9 FINISH COATING SYSTEMS

A. The following schedule lists coatings systems and coating surface designations. See Article 1-3 for a definition of the surface designations.

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
1.	Epoxy – One coat	x			x	x		
2.	Epoxy – Two coats	x	x	x	x	x		x
3.	Epoxy / NSF 61 – Two coats		x	x				
4.	Epoxy – Three coats	x	x	x				
5.	Epoxy / NSF 61 – Three coats	x	x	x				
6.	Epoxy – First coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		x
7.	Epoxy – First and second coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		
8.	Universal primer – First coat Aliphatic polyurethane – Finish coat	x		x				
9.	Medium consistency coal tar – Two coats	x	x	x				
10.	Coal tar epoxy – Two coats	x	x	x				
11.	Vinyl ester – Two coats	x	x	x				
12.	Heat resistant – Two coats						x	

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
13.	High heat resistant – Two coats						x	
14.	Zinc primer – First coat Epoxy – Intermediate coat Aliphatic polyurethane – Final coat	x		x				
15.	Flake-filled epoxy	x		x				
16.	Acrylic Latex Emulsion		x					x

B. Surfaces Not To Be Coated

1. Unless otherwise specified, the following surfaces shall be left uncoated:

   a. Exposed aluminum, except ductwork.
   b. Polished or finished stainless steel. Unfinished stainless steel, except flashings and counter flashings, shall be coated.
   c. Nickel or chromium.
   d. Galvanized surfaces, except piping, conduit, ductwork, and other items specifically noted. Hot dipped galvanized fabrications, including fabricated pipe supports, except where specifically noted.Rubber and plastics, except as specified.
   e. Exterior concrete.
   f. FRP wastewater troughs.
   g. Surfaces specified to be factory finished.

C. Shop Finishing

1. Items to be shop finished including the following. Shop finishing shall be in accordance with the coating manufacturer's recommendations.

   a. Surfaces where blast cleaning cannot be or is not recommended to be performed in the field.
   b. Other items as otherwise specified.

D. Field Coating

1. Items to be field coated include the following. Field coating shall be in accordance with the field priming schedule, the coating schedule, and the manufacturer's recommendations.

   a. Surfaces not indicated to be shop finished and surfaces where blast cleaning can be performed in the field.
   b. All interior ferrous metal surfaces except stainless steel on the digester cover.
   c. Other items as otherwise specified.

3.10 METAL SURFACES COATING SCHEDULE

Surfaces to be coated shall include new work, including Owner furnished equipment and surfaces disturbed by the Work. Surfaces that are not disturbed will not require recoating unless noted otherwise on the Drawings.

Surface To Be Coated	Finish Coating System
Non-galvanized structural and miscellaneous steel exposed to view or to the elements in exterior locations.	A6
Non-galvanized structural and miscellaneous steel exposed to view inside buildings.	A2
Steel handrails, steel floor plates, door frames.	A8
Unless otherwise specified, pumps, motors, speed reducers, and other machines and equipment exposed to view.	E8
Actuator surfaces for weirs unless factory finished.	Outdoor – E7, Indoor – E6
Metal curbs for skylights and power roof ventilators.	A1
Heating and air conditioning units, convector covers, electrical equipment cabinets, and similar Items and equipment (unless factory finished) exposed to view.	E8
Steel yard lighting poles exposed to view or to the elements.	A8
Cast Iron and steel piping inside buildings, including piping to be insulated, valves, fittings, flanges, bolts, pipe support, hangers, and accessories	A2
Pipe supports, hangers, bolts, and accessories inside buildings	A2
Cast Iron and steel piping in immersion service including inside buildings, including valves, fittings, flanges, bolts, pipe support, hangers, and accessories	A4
Pipe supports, hangers, bolts, and accessories in immersion service including inside buildings	A4
Cast Iron and steel piping above grade exposed to the elements and to view outdoors, including piping to be insulated, valves, fittings, flanges, bolts, pipe support, hangers, and accessories	A6
Pipe supports, hangers, bolts, and accessories above grade exposed to the elements and to view outdoors	A6
Copper pipe and tubing, including fittings and valves.	F2
Copper pipe and tubing, including fittings and valves exposed to view in exterior locations.	F7
Surface aeration equipment, all Iron and steel surfaces except stainless steel, motors, and speed reducers.	E4

Surface To Be Coated	Finish Coating System
All metal surfaces, unless otherwise specified, which will be submerged or buried, all or in part, including valves, and scum baffles, and cast iron slide gates, but excluding piping laid in the ground.	E4
All fully or partially submerged surfaces of screening, grit removal, aeration mixing, and sludge mixing equipment.	E4
Miscellaneous castings, including manhole rings and covers, and manhole steps. (One coat, if not shop coated.)	A10
Cast iron and steel piping in manholes, wetwells, grit basin, aeration basin, and similar locations, including valves fittings, flanges, bolts, supports, and accessories.	A10
All metal harness anchorage for buried piping.	A10
Supports and miscellaneous metal for equipment handling corrosive chemicals.	Outdoor – A6 Indoor – A2
Aluminum in contact with concrete.	F1
Aluminum and galvanized ductwork and conduit indoors.	F2 or G2
Aluminum and galvanized ductwork and conduit exposed to elements outdoors.	F6 or G6
Aluminum materials exposed to the elements outdoors.	F6

3.11 CONCRETE AND MASONRY SURFACES COATING SCHEDULE

Surfaces to be coated shall include new work and surfaces disturbed by the Work. Surfaces that are not disturbed will not require recoating unless noted otherwise on the Drawings.

Surface To Be Coated	Finish Coating System
All concrete and concrete block in corrosive areas (Except floors and surfaces scheduled to receive other coatings) which are exposed to view.	Indoor –C2Outdoor –C7
Where indicated on the Drawings, walls, floors, and curbed areas, adjacent to corrosive chemical storage and feed equipment.	C2
Interior walls for architectural finish only	C2

3.12 PIPING IDENTIFICATION SCHEDULE

A. Exposed piping and piping in accessible chases shall be identified with lettering or tags designating the service of each piping system, marked with flow directional arrows, and color coded.

B. Piping scheduled to be color coded shall be completely coated with the indicated colors, except surfaces specified to remain uncoated shall include sufficiently long segments of the specified color to accommodate the lettering and arrows. All other piping shall be coated to match adjacent surfaces, unless otherwise directed by Engineer.

C. Location

1. Lettering and flow direction arrows shall be provided on pipe near the equipment served, adjacent to valves, on both sides of wall and floor penetrations, at each branch or tee, and at least every 50 feet in straight runs of pipe. If, in the opinion of Engineer, this requirement will result in an excessive number of labels or arrows, the number required shall be reduced as directed.

D. Metal Tags

1. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, aluminum or stainless steel tags shall be provided instead of lettering. Tags shall be stamped as specified and shall be fastened to the pipe with suitable chains. Pipe identified with tags shall be color coded as specified.

E. Lettering

1. Lettering shall be painted or stenciled on piping or shall be applied as snapon markers. Snapon markers shall be plastic sleeves, Brady "BradysnapOn B915," Seton "Setmark," or equal. Letter size shall be as follows:

Outside Diameter of Pipe or Covering	Minimum Height of Letters
5/8 inch and smaller	Metal tags -1/4 inch
3/4 to 4 inches	3/4 inch
5 inches and larger	2 inches

F. Color Coding and Lettering

1. All piping for the following services shall be color coded. Bands shall be 6 inches wide spaced along the pipe at 5 foot intervals. For services not listed, the color coding and lettering shall be as directed by the Engineer.

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Combustion Air	Dark green yellow bands	White

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Compressed Air	Dark green	Black
Condensate	Light gray with brown bands	Black
Drain	Dark gray	White
Fire Protection Water	Red	White
Fuel Oil	Black	White
Natural Gas Or Propane Gas	Yellow with red bands	Black
Nonpotable Water (downstream of backflow preventer)	Purple	Black[2]
Other Hydrocarbons (identify)	Black	White
Plant Effluent Water	Purple	Black[3]
Plumbing Vents	Dark gray	White
Potable Water (hot or cold)	Dark blue	White[4]
Sample	Light gray with green bands	Black
Sewage	Dark gray	Black
Sodium Bisulfite	Orange with black bands	Black
Sodium Hypochlorite	Orange with red bands	Black
Sulfuric Acid	Yellow with red bands	Black

G. Notes:

1. Lettering shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK.”

2. Lettering shall be on a yellow background and shall read, “CAUTION: NONPOTABLE WATER, DO NOT DRINK.” Each outlet on the nonpotable water line shall be similarly labeled.

3. Lettering shall read, “CAUTION: RECLAIMED WATER, DO NOT DRINK.”

4. Lettering shall be on a light green background.

5. Electrical conduit shall be coated to match adjacent ceiling or wall surfaces as directed by Engineer. Vent lines shall be coated to match surfaces they adjoin.

6. In addition, special coating of the following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes

7. Numerals at least 2 inches high shall be painted on or adjacent to all accessible valves, pumps, flowmeters, and other items of equipment which are identified on the Drawings or in the Specifications by number.

End of Section

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BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 1- 09 96 11

SURFACE DESCRIPTION	SYSTEM NO.

SURFACE PREPARATION DESCRIPTION

- ☐ Solvent SSPC-SP1
- ☐ Ferrous Metal Nonimmersion SSPC-SP6
- ☐ Ferrous Metal Immersion
  - ☐ SSPC-SP10
  - ☐ SSPC-SP-5
- ☐ Other

COATING	**DFT** mils	MANUFACTURER AND PRODUCT
First Coat (Primer)		
Second Coat		
Third Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:

Coatings Manufacturer: Initials _____

Painting Applicator: Initials _____

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SHOP PRIMED SURFACE DESCRIPTION SYSTEM NO. - -F

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1
☐ Other

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
Shop Primer		(Identify Product/Type)
Touchup		
Intermediate Coat		
Finish Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:	
Coatings Manufacturer:	Initials _____
Painting Applicator:	Initials _____

BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 2- 09 96 11

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SECTION 09 9724 - CORROSION PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing and installation of corrosion protection systems to be applied to floors and walls at the chemical storage facilities as specified herein and as indicated on the Drawings. This section covers concrete surface preparation, furnishing and application of a corrosion protection system suitable for each set of specified service conditions, the engineering field services to be provided by the material manufacturer and applicator as well as any appurtenances that are required to provide a completed corrosion protection system.

1.2 QUALITY ASSURANCE

1. Manufacturer's Field Services

    a. The field services provided by the material manufacturer shall include review of the project before surface preparation; certification of the manufacturer’s product for the application; approval of the applicator, the materials, and the procedure to be used; approval of the surface preparation; and approval of the application.
    b. A representative of the corrosion protection system material manufacturer shall submit, through Contractor, written approvals/certification of the proposed protection system materials, application procedures, applicator, and surface preparation requirements. The representative shall be an employee of the material manufacturer.
    c. Contractor shall notify the material manufacturer and Engineer at least 10 days prior to anticipated date of the commencement of corrosion protection system work.

B. Applicator Field Services

1. Contractor shall employ the services of a qualified corrosion protection system application contractor (Applicator). The Applicator of the corrosion protection system shall contact the corrosion protection system material manufacturer during the bidding phase of the project and shall include in the cost of this work and the estimated cost of the manufacturers engineering field services as specified.

2. The corrosion protection system Applicator shall submit a satisfactory experience record including references for previous application of the specified corrosion protection systems to concrete structures of similar design and complexity. The material

manufacturer shall approve the Applicator in writing. After the application is complete, the Applicator of the corrosion protection system shall certify that the corrosion protection system is free of pinholes and holidays.

3. The Applicator shall also perform and provide the adhesion testing and results to determine compliance with the specified minimum pull-off adhesion strength.

4. Following the application, the Applicator shall certify that the corrosion protection system is free of pinholes and holidays.

1.3 SUBMITTALS

A. Drawings and Data

1. In accordance with the Submittals Procedures section, complete specifications and data on the protection system, application instructions for the protection system, and material manufacturer's approvals for the protection system furnished under this section shall be submitted for Engineer review. The lining manufacturer shall submit acceptable lining termination details and metal accessories encapsulation details.

B. Certifications

1. The corrosion protection system manufacturer shall provide a certification statement for each component of the corrosion protection system that it will provide corrosion resistance for the specified service conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. The material shall be delivered to the jobsite in original unopened containers with labels intact. Protection system components shall be stored indoors in an appropriate location and environment in accordance with the manufacturer's recommendations and shall be protected against freezing.

B. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.5 WARRANTY

A. Material manufacturer shall warrant the chemical resistance of each corrosion protection system (products and labor) for a period of three years from the date of Substantial Completion when exposed to the customer's normal operating conditions as stated in the specification. This warranty shall not cover wear and tear such as abrasion resistance or mechanical abuse.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Service Conditions

1. The corrosion protection system shall provide splash and spill protection for 72 hours from the chemicals as specified herein.

2. Surfaces to be coated are new and/or existing concrete and incidental steel.

2.2 MATERIALS

A. Materials shall be suitable for the specified service conditions. Products composing the corrosion protection system shall be chemically resistant to the chemicals, concentrations, temperatures, exposure times, and other relevant service conditions. In many cases, repair materials, primers, flexible basecoats, and other ancillary products that will be protected by a corrosion resistant and/or wear resistant layer of the protection system and may not be required to meet these criteria provided the overall protection system complies with the performance criteria.

B. Corrosion protection systems specified herein shall be the type of product/system specified for the services and shall be the products of Dudick Inc., Carboline Company, Tnemec Company, International Paint, LLC/Ceilcote, Stonard, without exception. The products of other manufacturers and/or their corrosion protection systems will not be acceptable.

C. Epoxy Protection Systems

1. Service Conditions for Epoxy Protection Systems

a. Chemicals to be contained at the maximum chemical temperature of 120° F that are corrosive to concrete:
1) Sodium bisulfite; 38% conc.

b. Epoxy protection systems will not be exposed to sunlight, UV, and outdoor atmosphere

2. System Requirements for Epoxy Protection Systems.

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where mat reinforce with flexible basecoat lining system is required:	Sodium bisulfite containment area including containment floor, walls, and equipment pads.

3. Epoxy Flexible Lining Protection System

a. When an epoxy lining system with a flexible basecoat is required, the corrosion protection system shall be a two-component, 100 percent solids, solvent-free, epoxy resin, silica filled, fiberglass mat reinforced flexible basecoat, high-build protective and waterproofing lining. All resins in this system shall be 100 percent solids with at least two components. The concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. The basecoat shall be a flexible epoxy resin with silica fillers with a chopped strand mat reinforcement and saturant. The finish coats shall be epoxy resin.

D. Vinyl Ester With Graphite Filler Protection Systems

1. Service Conditions for Vinyl Ester With Graphite Filler Protection Systems

a. Chemicals to be contained at the maximum chemical temperature of 120° F , unless otherwise indicated, that are corrosive to concrete:
1) Sodium hypochlorite; up to 15% conc.

2. Vinyl ester with graphite filler protection systems will not be exposed to sunlight, UV, and outdoor atmosphere.

3. System requirements for Vinyl Ester With Graphite Filler Protection Systems

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Sodium hypochlorite containment area including containment floor, walls, and equipment pads.

4. Vinyl Ester With Graphite Filler Flexible Lining System

a. The corrosion protection system shall be a two component, 100 percent solids, solvent-free, vinyl ester resin, graphite filled, mat reinforced flexible basecoat, high-build protective and waterproofing lining. Concrete surface primer shall be an epoxy resin primer containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be epoxy resin with silica fillers. Reinforcement shall be chopped strand mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, solvent-free, graphite filled vinyl ester resin.

E. Novolac Epoxy Protection Systems

1. Service Conditions for Novolac Epoxy Protection Systems

a. Chemicals to be contained at the maximum chemical temperature as indicate that are corrosive to concrete:

1) Sulfuric acid; up to 98% conc. at 150° F .

b. Novolac epoxy protection systems will not be exposed to sunlight, UV, and outdoor atmosphere.

2. System requirements for Novolac Epoxy Protection Systems

Type of lining system.	Lining, mat reinforced with flexible basecoat.
Location(s) where a mat reinforced with flexible basecoat lining corrosion protection system is required:	Sulfuric acid containment area including containment floor, walls, and equipment pads.

3. Novolac Epoxy Flexible Lining Protection Systems

a. The novolac epoxy corrosion protection system shall be a two component, 100 percent solids, solvent-free, novolac epoxy resin, silica filled, high-build protective and waterproofing coating. Concrete surface primer shall be an epoxy resin containing 100 percent solids. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. Flexible basecoat with reinforcement shall be an epoxy resin with silica fillers and chopped strand fiberglass mat. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two component, 100 percent solids, novolac epoxy resin.

F. Epoxy Filler Compound

1. Epoxy filler compound for concrete surfaces shall be a two-component, 100 percent solids epoxy filler or as recommended by the corrosion protection system material manufacturer.

G. Corrosion Resistant Caulking/Sealant

1. Chemical resistant caulking/sealant shall be suitable for the specified service conditions and shall be as recommended, in writing, by the protection system material manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. All details, methods, and procedures of mixing, surface preparation, bonding, application, finishing, curing, and protection of the protection system shall be in strict accordance with the recommendations of the material manufacturer. The applicator shall comply with the recommendations of the material manufacturer.

3.2 SURFACE PREPARATION

A. All surfaces shall comply with the SSPC/NACE guidelines for surface preparation as specified herein and shall meet the manufacturer's recommendations for surface preparation.

B. All surfaces shall be dry when coated or lined, and shall be free from dirt, dust, sand, mud, oil, grease, rust, mill scale, and other objectionable substances. Oil and grease shall be completely removed as recommended by the material manufacturer before mechanical cleaning is started.

C. Concrete Surfaces

1. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6 and the lining material manufacturer's recommendation. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film.

2. New concrete shall be cured for at least 28 days before lining is applied and shall be ready to receive the lining as determined by the Applicator and material manufacturer. Concrete surfaces shall be tested for capillary moisture in the concrete in accordance with ASTM D4263. There shall be no capillary moisture migration after 24 hours as determined by the test method. If moisture is observed, the corrosion protection system shall include a vapor barrier that is recommended by the protection system manufacturer.

3. All concrete surfaces to be lined shall be cleaned in accordance with ASTM D4258 and abrasive blasted in accordance with ASTM D4259. Before the lining is applied, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. The Contractor shall repair all concrete surfaces that have spalls, voids, and cracks and shall remove all fins and other surface projections to produce a flush surface for application of the protection system.

4. Surface profile shall be at least 4 mils for a coating protection system and at least 22 mils for a lining protection system, but shall not be less than 25 percent of the dry film thickness specified for the corrosion protection system or 40-60 grit sandpaper unless recommended otherwise by the material manufacturer.

5. Concrete surfaces shall be pinhole free as using an epoxy concrete filler or as recommended by the material manufacturer and acceptable to Engineer.

6. Existing Concrete

   a. Existing concrete shall have all existing lining products completely removed before the application of a new corrosion protection system. For existing concrete, unless it can be verified that existing concrete has a vapor retarder, applied beneath it, the application shall include a surface-applied vapor barrier product before the lining system is applied.
   b. If any repairs to existing concrete are required, they shall be made as part of the surface preparation in accordance with the Concrete Surface Repair section prior to the application of lining products.

7. Adhesion Testing

   a. Adhesion testing shall be conducted, by the Applicator, at each application area, after the concrete surfaces has been prepared and approved by the Applicator and lining material manufacturer. Adhesion strength test results shall exceed 400 psi or a higher value if recommended by material manufacturer. Adhesion test results shall be presented to and approved by Owner/Engineer, Applicator, and lining material manufacturer.
   b. The test area shall be at least 2 square feet to allow a minimum of three tests to be conducted. Pull-off strength adhesion tests shall be conducted by the Applicator in accordance with ASTM D7234 for concrete surfaces using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed the minimum adhesion strength specified herein and by the material manufacturer.

D. Metal Surfaces

1. Metal surfaces shall be prepared in accordance with the following: All sharp edges, and corners are to be ground smooth, Welds are to be ground smooth, in accordance with NACE standard RP0 178, Appendix C. Designation C, shall have all weld slag and splatter removed and be free of all defects. The surfaces shall be abrasive blasted in conformance with SSPC SP-10 and shall be at least a 3 mil surface profile.

3.3 MIXING AND THINNING

A. Materials shall be thoroughly mixed each time any is withdrawn from the container, and the containers shall be kept tightly closed except while the material is being withdrawn.

B. Corrosion protection system components shall be mixed to proper consistency and viscosity in accordance with the manufacturer's recommendations. Thinning will not be permitted. No adulterant, unauthorized thinner, or other material not included in the formulation, shall be added to the protection system components for any purpose

3.4 APPLICATION

A. Corrosion protection systems shall be applied in accordance with the manufacturer's recommendations and in a neat manner, with finished surfaces free of runs, sags, ridges, laps, and brush marks. In no case shall the dry film thickness of applied protection system be less than the thickness recommended by the material manufacturer.

B. Grit shall be broadcast into first finish lining coat to produce an anti-skid surface.

C. Each coat shall be applied over the previous coat in accordance with the recommendations of the material manufacturer. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness. In no case shall coating be applied at a rate of coverage which is greater than the maximum rate recommended by the material manufacturer.

D. Recoating shall be applied in accordance with manufacturer's recommendations.

E. Alternate coats shall be of contrasting colors to facilitate in obtaining complete coverage. The first coat shall be a dark color.

F. Corrosion protection systems showing checks, blisters, excessive sags, teardrops, or fat edges will not be acceptable and shall be entirely removed and the surface recoated. The protection system shall be free of pinholes and holidays.

G. Corrosion protection systems shall be applied when surface temperature is at least 50° F and at least 5° F above dewpoint, and relative humidity is 85 percent or lower. Protection system shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the protection system shall be applied when the temperature of the concrete is dropping.

H. When applying high build protection system with a roller or brush and where a dry film thickness of at least 4 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

I. Epoxy Protection Systems

1. Epoxy Flexible Lining Protection System

a. The corrosion protection system shall be applied in four or more coats. The system shall consist of one prime coat, one basecoat with reinforcement and saturant, and two or more finish coats. The prime coat shall be at least 6 mils wet film thickness (WFT). The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 8 mils dry film thickness (DFT). The protection system shall have a total thickness of at least 90 mils DFT.

J. Vinyl Ester With Graphite Filler Protection Systems

1. Vinyl Ester With Graphite Filler Flexible Lining System

a. The corrosion protection system shall be applied in four or more coats. The corrosion protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 5 mils . The flexible basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils .

K. Novolac Epoxy Protection Systems

1. Novolac Epoxy Flexible Lining Protection Systems

a. The corrosion protection system shall be applied in four or more coats. The protection system shall consist of one prime coat, one basecoat, reinforcement and saturant, and two or more finish coats. The prime coat wet film thickness shall be at least 4 mils . The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils dry film thickness. The protection system shall have a total dry film thickness of at least 100 mils .

L. Epoxy Filler

1. An epoxy filler shall be used in a 1 inch minimum radius to fill in floor to wall joints for a liquid tight joint.

M. Corrosion Resistant Caulking/Sealant

1. Corrosion resistant caulking/sealant shall be used at any penetration in the lining, such as at anchorage of pipe supports and chemical storage tanks.

3.5 FIELD QUALITY CONTROL

A. Finished surfaces shall be cleaned and prepared as needed to properly conduct the visual inspection, spark testing, and adhesion testing. All inspection and testing shall be witnessed by Applicator and Material Manufacturer. Repairs shall be acceptable to Engineer.

B. Visual Inspection

1. The surface of the liner shall be visually inspected for areas defects, air inclusion, pinholes, or other imperfections in the system that may prevent a complete seal of the surfaces.

C. Spark Testing

1. Where practical, after liners are installed, the applicator shall spark-test all lined metal surfaces using an acceptable high-voltage electrical spark tester set at the recommended voltage. The material manufacturer shall verify the testing equipment is working properly before beginning the spark testing of the lining. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the lining surface.

D. Adhesion Testing

1. The Owner/Engineer reserves the right to require adhesion testing of any finished corrosion protection system application specified herein. Adhesion testing shall be conducted as specified in Paragraph 3-2.01.01 above by the Applicator. Adhesion strength test results shall exceed 300 psi or a higher value. Finished system adhesion test results shall be presented to and approved by Owner/Engineer, Applicator, and lining

material manufacturer. Following adhesion testing, the area(s) tested shall be repaired by the Applicator with the specified products and methods specified herein.

2. If the finished system fails an adhesion test, the cause of the failure shall be determined and corrected before the test is repeated on a new test area. If the adhesion test fails a second time, the Owner/Engineer reserves the right to require the entire surface to be completely removed and reapplied at no cost to the Owner/Engineer.

E. Film Thickness

1. Coating film thickness shall be verified by measuring the wet film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil. Dry film thickness for concrete shall be measured using a Defelsko Positector 200 series or equal, in accordance with SSPC-PA9 (concrete) and PA2 (steel). At the discretion of the Owner/Engineer, core samples could be obtained for measuring dry film thickness.

3.6 PROTECTION

A. Care shall be taken to prevent coating from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or painted as acceptable to Engineer.

End of Section

SECTION 10 40 00

IDENTIFYING SIGNAGE

PART 1 – GENERAL

1.01. SCOPE. This section covers the furnishing and installing of signs, and identification devices, such as warning signs and symbols, which indicate hazards, identify objects, rooms and devices, provide instruction, and convey information with the intent to eliminate, in so far as possible, accidental injury to workers and the public or damage to the property.

Identifying sign locations, wording, and letter styles and sizes shall be as specified herein.

Types of products required include the following:

- Exterior Building Signage
- Interior Signage System
- Hazardous Chemical Area Warning and Information Signs
- Warning Signs
- No Smoking Signs
- Safety and Warning Labels
- Miscellaneous Signs
- Fire Barrier Identification Signage
- Dedication Plaque

1.02. GENERAL. Identifying signs shall be manufactured by firms regularly engaged in the production of high quality signs. Graphics and lettering shall be neatly aligned with sharp, clean edges. Signs displaying ragged edges or other indications of poor workmanship will be rejected.

The identifying tags and signs shall be provided with all of the necessary connectors, supports, fasteners, and adhesives required for complete finished installation. Contractor shall verify all sign graphics and obtain approval from the local Fire Marshall and Building Official with jurisdictional authority before fabrication. The Contractor shall verify all signage text, colors, location, and other design features not directly governed by code with the Owner and Engineer before fabrication.

1.04. SUBMITTALS. Contractor shall submit the following items in accordance with the requirements specified in Submittals Procedures section. Items requiring submittals shall include, but not be limited to, the following:

Manufacturer’s information, including manufacturer’s specifications and installation instructions.

Shop drawings consisting of full-size layouts of all signs, including directional signs incorporating all features, mountings and accessories. Repetitive sign layouts of typical and most restrictive condition shall be submitted. Details of installations shall be submitted showing fasteners and mounting. Style and colors of lettering shall be as selected by the Engineer from manufacturer's standards.

Samples of all the sign materials and colors proposed for use on the project. The samples shall be clearly marked to show the manufacturer's name and product identification and shall be submitted along with the manufacturer's technical data and application instructions.

1.05. PROJECT CONDITIONS. Contractor shall verify field conditions of the areas of installation, take measurements at the site prior to fabrication, and indicate field dimensions on the shop drawing submittal. Contractor shall coordinate fabrication schedule, delivery and progress schedule with the project manager and project site construction manager to avoid delays.

PART 2 – PRODUCTS

2.01. EXTERIOR CAST ALUMINUM SIGNAGE. The Chemical Building shall have exterior letters provided on the building exterior of cast aluminum and equal to products manufactured by the A.R.K.-Ramos Company, Supersine Company, Andco Industries Corporation, or approved equal. Letter heights shall be 8" and styles shall be "Futura" design raised stud mounted, furnished and complete installation. The letters shall have an anodized finish, selected from the manufacturer's standard anodic finishes. Faces and sides of letters shall be machined and shall have a satin finish. Each piece shall be anchored to the wall by means of at least two stainless steel stud bolts, threaded both ends, threaded into the back side of the letter.

At masonry walls, the stud bolts shall be set in quick-setting, non-staining cement mortar in suitable holes drilled through the stucco and insulation, into the CMU back-up wall. Stud bolts shall be provided with stainless steel sleeves and be of such length, so that the letters will be approximately 1/2 inch from the face of the wall when installed.

One full-size paper template shall be provided, indicating the spacing for each line of letters and the locations of all stud bolts, as a guide for the drilling of holes in the masonry wall.

Final exterior building signage text and location shall be coordinated with the Owners and the Engineer. The exterior lettering proposed for the Chemical Building shall be as follows:

City of Venice
Chemical

2.03. HAZARDOUS CHEMICAL AREA WARNING and INFORMATION SIGNS. Door-mounted hazardous chemical area warning signs shall be determined after award of the contract and provided at all chemical room entrances as required by local Fire Marshall. These signs shall be diamond-shaped with four color quadrants conforming to NFPA 704. The exact location, number, and text of the signs shall be as determined by the local Fire Marshall with jurisdiction. These signs shall be 10-inch square overall size and shall be equivalent to Seton Name Plate Co. "Metal-backed butyrate (BMB)". Style shall be suitable for screw fastening to metal doors and attachment to storage tanks. Final signage shall be selected from the manufacturer's standards, submittal and be approved by the Engineer.

Hazardous chemical warning signs shall be furnished and installed for the chemicals pertinent to the project. The degree of hazard shall be acceptable to the Fire Department. Each sign shall be 10 inch square with 3 inch size numbers. A sign shall be provided on each tank and each room entrance. Chemical warning sign requirements shall be determined after award of the contract.

2.04. WARNING SIGNS. Warning signs shall be furnished and installed in the specified location and with the specified wording as indicated below.

Each sign shall be in accordance with the Federal Occupational Safety and Health Act - OSHA Regulations 1910.145. The signs shall be 14 inches by 10 inches, and shall be plastic, semi-rigid "01900 Series" Industrial Safety and Security Co., Lima, Ohio. Signs shall be as follows:

The following sign shall be permanently affixed at the entrances to the Chemical Room:

DANGER – HYPOCHLORITE

The following sign shall be installed on the exterior of doors leading into electrical rooms, enclosures, and cabinets:

DANGER
HIGH VOLTAGE

2.05. NO SMOKING SIGNS. A "No Smoking" sign, combination of words and symbol, shall be mounted on each door to each chemical room or storage area. Signs shall be 17 inches by 7 inches, and shall be plastic, semi-rigid, Industrial Safety and Security Co. "Catalog No. 03146(2)".

2.06. SAFETY AND WARNING LABELS. Safety and warning signs and labels shall be furnished and installed to indicate and define hazards which may lead to accidental injury to personnel or to property damage. The signs and labels shall be constructed of stainless steel. The sign size, shape, and color shall be in accordance with the Occupational Safety and Health Act (OSHA), Federal Register Part 2, Paragraph 1910.45.

2.07. MISCELLANEOUS SIGNS. All miscellaneous signs shall be stainless steel. Colors of the field and lettering shall be selected from the manufacturer's standard colors by the Engineer and agreed by the Owner. Size of the signs shall be sufficient to allow for all necessary information but must not interfere with normal operations of the equipment.

2-08. FIRE BARRIER IDENTIFICATION. All fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions, or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs according to Chapter 7 of the Florida Building Code.

Identification shall be painted with stencils and located within 15-feet of the end of each wall and at intervals not exceeding 30-feet measured horizontally along the wall or partition.

Lettering shall be not less than 3-inches in height with a minimum 3/8-inch stroke in a contrasting color. Text shall be similar to the following with the first line adjusted to match the applicable wall type:

FIRE BARRIER
PROTECT ALL OPENINGS

2.09 DEDICATION WALL PLAQUE. A dedication plaque shall be provided and installed in the Chemical Hall 101 inside door 101A or alternate location coordinated with the Owner. Plaque shall be cast aluminum approximately 18 inches by 28 inches. The exact size and lettering of the inscription to be placed thereon will be furnished to the Contractor after the award of the Contract. The tablet shall not be less than 3/16 inch thick and shall have lettering, center panel, and trim raised not less than 1/8 inch. The face and edge of the border, center panel, and the faces of lettering shall have a fine satin finish. Background shall have a leatherette textured surface and shall be oxidized to a dull black color. The outlines of all lettering and borders shall be hand-tooled, clean and sharp. The plaque shall be mounted using suitable concealed fasteners. A rubbing of the pattern shall be submitted for review before casting. Sign shall be selected from the manufacturer's submittal and be approved by the Engineer.

PART 3 – EXECUTION

3.01. INSTALLATION. All products herein shall be installed as recommended by the manufacturer and as indicated on the drawings. All moving parts shall be properly lubricated and adjusted as required for proper operation. Location of all signs shall be as indicated by the Engineer, local fire authorities, or by local code.

3.02. CLEANING. In accordance with the requirements of the manufacturer's printed recommendations, all signs shall be thoroughly cleaned and left ready for use.

End of Section

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SECTION 10 99 00 - MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the miscellaneous items of work not covered in other sections, including:

1. Fire Extinguishers
2. Splash Blocks

1.2 GENERAL

A. Miscellaneous specialties shall be furnished and installed as specified herein and in accordance with the details, arrangements, and dimensions indicated on the Drawings. Where not specifically indicated or specified, fasteners, gaskets, and other accessories shall be provided as required and as recommended by the manufacturer of the specific item.

1.3 SUBMITTALS

A. Complete specifications, detailed drawings, and setting or erection drawings covering miscellaneous specialties shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. Multipurpose Dry Chemical Fire Extinguisher

1. Portable fire extinguishers of the all-purpose, nitrogen-pressured, dry chemical type shall be provided as scheduled herein. Fire extinguishers shall be UL-approved for Class A, B, and C fires and shall have a 10-pound capacity, such as Badger "10ABC", Buckeye "10S-ABC", or Kidde "Pro 460". Finish of shell shall be red with all metal handle and valve. Class ABC fire extinguishers shall be mounted 42-inches above finish floor or as required by the NFPA. Wall lettering shall be included above all fire extinguisher locations.

B. Carbon Dioxide Fire Extinguisher

1. The fire extinguishers which are noted below to be UL-approved for Class C fires and shall have a 10-pound capacity, such as Badger “B10V-1”, Buckeye “10CD”, or approved equal. Finish of shell shall be red with all metal handle and valve.

C. Fire Extinguisher Schedule

1. Wall-mounted fire extinguishers shall be mounted on suitable wall brackets at the specific locations designated by the Engineer. The following fire extinguishers shall be provided:

Chemical Building

Room Location	Quantity	Mounting
Chemical Room (Class ABC) near each exit door	2	Wall Bracket
Bisulfite Room (Class ABC) near exit door	1	Wall Bracket
Electrical Room (Class C) near exit door	1	Wall Bracket
Mechanical Room (Class C) near exit door	1	Wall Bracket

D. Fire Extinguisher Cabinets

1. Fire extinguisher cabinets shall be provided and installed at the locations indicated in the above schedule. Cabinets shall be Larson Architectural Series, full-glass style, "Model AL-2712-R". Cabinets shall be semi-recessed type with trim. Trim and door shall be finished in anodized aluminum. The box shall be finished in white baked enamel. Engineer will select anodized finish from manufacturer's standard range.

2.2 SPLASH BLOCKS

A. Precast reinforced concrete splash blocks shall be provided at the locations indicated on the Drawings.The blocks shall be approximately 16 inches wide by 30 inches long by 5 inches high, with curbs on three sides. The splash portion shall be sloped from not less than 1 inch depth at the inlet end to not less than 2 inches at the outlet end. The block shall be reinforced with not less than WWF4X4-W4XW4 welded wire fabric.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All products herein shall be installed as recommended by the manufacturer and as indicated on the Drawings. All moving parts shall be properly lubricated and adjusted as required for proper operation.

End of Section

SECTION 13 12 0 - FIBERGLASS REINFORCED PLASTIC ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and installation of one fully insulated, pre-engineered, freestanding, fiberglass reinforced plastic (FRP) building, including lighting panel, lighting fixtures and switches, receptacles, electrical cabling and conduit, doors, heating and ventilation, and a concrete pad. The enclosure shall house pipes, valves, and instrumentation associated with the cooling water force main and all other equipment and items specified herein and as shown on the drawings. The size, layout, and elevations of the enclosure shall be as shown on the drawings, and modified as needed to coordinate with the actual equipment provided inside the shelters.

B. The FRP enclosure shall be equipped with doors, exhaust fans, louvers, dampers, heaters, lighting fixtures and switches, receptacles, electrical cabling and conduit, and all other appurtenances specified or otherwise required for a complete weather-tight building. Contractor shall coordinate location and sizes of openings for electrical conduit, louvers, exhaust fans, and vent piping to equipment, and all openings shall be formed in the factory to the greatest extent practicable or modified in the field to the requirements of the shelter manufacturer.

1.2 GENERAL.

A. Equipment provided under this section shall be designed, fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the enclosure manufacturer, unless exceptions are noted by Engineer.

B. The shelter provided under this section shall be the product of a manufacturer regularly engaged in the production of high-quality fiberglass reinforced plastic shelters. At a minimum, manufacturer shall have furnished 3 enclosures of similar size and use and been in successful service for 10 years.

C. The erector/installer shall not have less than 2 years' experience in offloading and installation of prefabricated structures.

D. The manufacturer shall have an entire fiberglass panel destructive tested by an accredited Testing Laboratory and Third Party Quality Control Agency and upon request shall furnish to the Engineer the certified and stamped test results of the laboratory testing. The accredited Testing Laboratory must be accredited to ISO 17020 and 17025. The manufacturer shall maintain a quality assurance program that is reviewed and approved by a Third Party Quality Control Agency.

E. The building dimensions shall be as indicated on the Drawings and as characterized below.

1. Shelter Name: Proctors Creek Sidestream Treatment Valve Enclosure

a. Size:
1) Exterior Width: 8 ft
2) Exterior Length: 16 ft
3) Wall Height: 7.5 ft

b. Roof Slope: Sufficient to allow rain drainage, 12o – 17o pitch.
c. Roof Type: Roof shall be wind-resistant “hip” design sloping up from all four sides. Roof shall form a permanent weather-proof connection with a seamless exterior appearance that uses low-maintenance silicone caulk matching the shelter’s exterior color.
d. Roof deck is compliant with ASTM E 108/ULC S107 (class C) with <13’ Flame Spread.
e. Roof shall not overhang walls in order to maximize shelter’s wind speed rating.

F. The building shall include openings for all doors, windows, louvers, and other openings as needed and as indicated on the Drawings. The building shall include all personnel doors, hardware, windows, and louvers as indicated on the drawings and specified herein.

G. Anchors shall be designed and furnished as specified in the Anchorage In Concrete And Masonry section.

H. Coordination.

1. The FRP building manufacturer shall coordinate with Engineer and Contractor for the erection and field quality control of the building and appurtenances, installation of equipment, and the installation of any interior systems and finishes.

I. Governing Standards.

1. The building design and erection shall comply with all applicable federal, state, and local building codes.

2. Building erection shall comply with the applicable provisions of OSHA Standard 29 CFR 1926, Subpart R.

1.3 SUBMITTALS.

A. Complete shop drawings and manufacturer’s data showing the following:

1. Dimensions, weight, materials, parts, devices, and all other information required to verify compliance with these Specifications.

2. Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed system.

3. Drawings prepared specifically for this Project:

   a. Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt locations and details, lateral thrust details, cross-sections, roof and wall panels, structural members and bracing, accessories, flashing details, and openings prior to fabrication of the building.

4. Operations and Maintenance (O&M) Manual including installation instructions, digital version only, to be provided after shelter ships.

B. Data shall include design loads and load combinations, and a certified copy of all loadings transmitted to the support structure. A letter of design certification signed by a professional engineer registered in the state of Alabama shall be submitted with the drawings and data. Structural calculations in conformance with local building codes, including seismic requirements, shall be submitted.

C. Complete heating and ventilation (cooling) calculations shall be submitted. These calculations shall be subject to the approval and acceptance by the Engineer and shall be corrected and supplemented with additional information as required by the Engineer. All calculations shall be in accordance with the procedures listed in ANSI/ASHRAE/ACCA Standard 183. Heating and ventilation calculations shall be provided using an industry recognized software calculation program such as Elite CHVAC, Carrier Block Load or HAP, or Trane Trace. Calculations and drawings shall be sealed by a professional engineer registered in the state of Alabama. The heating and ventilation calculations shall include the following:

1. U-Value calculations

2. Equipment heat gain calculations for the electrical and lighting equipment in the building.

3. Building envelope heat gain/loss calculations.

4. Equipment sizing calculations to support equipment selected.

5. Static pressure calculations for the equipment selected.

D. Complete drawings showing the locations of lighting fixtures and switches, receptacles, and lighting panel along with the routing of cabling and conduit. A panelboard schedule for the lighting panel shall be submitted showing complete load calculations taking into account National Electrical Code (NEC) demand factors. These drawings and calculations shall be subject to the approval and acceptance by the Engineer, and shall be corrected and supplemented with additional information as required by the Engineer. Calculations and drawings shall be sealed by a professional electrical engineer in the state of Alabama.

E. Product technical data for lighting fixtures and switches, receptacles, lighting transformer, lighting panel, cabling and conduit. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

F. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.

G. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than once scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

H. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

I. Drawings shall be accompanied by the manufacturer's erection information indicating standard recommendations, erection details, and piece markings.

J. Color cards and samples indicating the manufacturer's available colors and finishes shall be submitted for color selection. Samples shall include an 8-inch square sample of representative fiberglass reinforced plastic laminate.

K. Complete details, model numbers, finishes, and installation drawings covering the pedestrian doors, door hardware, windows, and louvers shall be submitted.

L. Catalog cuts, drawings, and specification data and wiring diagrams for the heating and ventilation equipment shall be submitted. Materials of construction for heating and ventilation equipment shall be submitted. Fan tables and curves showing capacity (cfm), static pressure, and horsepower shall have the operating point clearly defined.

M. Provide sizes and locations of all wall penetrations.

N. Drawings and data shall be submitted in accordance with the Submittals Procedures section.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. All factory finished materials shall be protected for shipment in accordance with accepted packaging standards. Minor damage to finishes shall be touched up before installation following the manufacturer's recommendations. Any significantly damaged components shall be replaced at no cost to Owner. Anchor bolts and their accessories shall be coordinated with Contractor to be delivered in time to avoid delays in placing concrete.

1.5 WARRANTY.

A. Buildings shall be warranted to be free of defects in workmanship and materials for a period of two years from shipment. After final acceptance, the completed structure shall be warranted to be completely weathertight under all weather conditions for a period of ten years. Leaks which occur during this period, whether through roofs, walls, doors, or accessory equipment or materials, shall be repaired at no cost to, and to the satisfaction of, the Owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Minimum design loadings and requirements shall be in accordance with the applicable building code and as listed below. Load combinations shall be in accordance with the applicable building code.

1. A collateral dead load of 10 psf shall be applied to the roof in addition to the building system dead load. Reduction of load due to tributary loaded area will not be acceptable.

2. The enclosure shall be designed for the roof snow load, the wind loads, and other loads and design criteria as specified in Meteorological And Seismic Design Criteria.

3. Seismic loading and all other structural design requirements shall be as per the applicable building code and the design criteria specified in Meteorological And Seismic Design Criteria.

4. Building deflection limits shall be appropriate to prevent distress on the building or the equipment and accessories located inside of the building.

B. In addition, the building shall be designed to carry other loads, such as pipe and equipment, as indicated on the drawings. Secondary framing to carry these loads to the main building frames shall be provided with the building system unless otherwise specifically noted on the drawings.

C. Unless specifically authorized by the Engineer in writing, walls shall be considered “hinged” at their base. The building foundation shall not be required to accept either full or partial moment fixity from the building walls or extrusions. All anchorages shall be designed to resist wall and extrusion reactions from loading combinations.

D. The FRP building manufacturer shall determine the required anchorage, bolt diameters, projections, and arrangements suitable for the design building loads.

E. Provide a building with the following characteristics:

1. Minimum interior side wall height shall be 7’-0”

2. Internal size as indicated on Drawings.

3. Pre-engineered paneled fiberglass composite building or one piece molded construction.

2.2 HEATING AND VENTILATION

A. The ventilation and heating for the building shall be designed using the following ambient design conditions:

Summer:	94.9 F dry bulb/74 F wet bulb
Winter:	20.4 F dry bulb

B. The ventilation and heating for the building shall be designed to maintain a space condition of 60 F or above (winter) and 104 F or below (summer).

C. The ventilation system equipment size shall be based on detailed heat gain calculations following procedures outlined as previously described in Part 1. Accurate determinations of wall and roof “U” values shall be made from the actual building Specifications and Drawings. Building envelope, lighting, and internal equipment loads shall be included when determining the size of the ventilation equipment. For final equipment sizing, a safety factor of 10 percent shall be applied to the total cooling load for the ventilation equipment.

D. The ventilation equipment shall be sized on the more restrictive of 6 air changes per hour or as required to prevent the indoor temperature from exceeding the summer space design temperature when the summer outdoor design temperature occurs. The ventilation system shall be arranged to prevent short circuiting of the ventilation airflow.

E. Intake louvers shall be sized with free area velocity not exceeding 75 percent of the beginning point of water penetration velocity. The static pressure loss through the louver shall not exceed 0.15 in wc. The minimum free area for the louver at a size of 48 inches by 48 inches shall be no less than 54 percent. The louver shall have aluminum removable bird screen. Louvers shall be Ruskin or equal.

F. The ventilation system shall consist of intake louvers and exhaust fans. The fans shall be controlled by “HAND-OFF-AUTO” selector switches located at the entrance to the building. When a switch is in the “AUTO” position, the fans shall be controlled by wall mounted thermostats. The intake louvers and fans shall have motorized dampers that are proven open before a fan is energized and that close when the ventilation system is not in use to protect the room from ambient conditions. The fans shall be provided with aluminum bird screen. Fans shall be Greenheck, Loren Cook, or equal. The motorized dampers shall be Ruskin or equal.

G. The heating system shall be sized based on a detailed heat loss calculation that follows procedures outlined as previously described in Part 1. Accurate determinations of wall and roof "U" values shall be made from the actual building Specifications and Drawings. Building envelope and infiltration loads shall be included when determining the size of the heating equipment. For equipment sizing, a safety factor of 10 percent shall be applied to the total heating load.

H. The heating system shall be designed to maintain the winter indoor design temperature when the winter outdoor design temperature occurs. The heating system shall consist of electric unit heaters controlled by wall mounted thermostats. The heaters shall be suitable for 208 volt, 60 Hz, 3 phase electrical service. The heaters shall be positioned to provide heat to all areas of the room in the building. Heaters shall be Chromalox "LUH", Brasch, or equal.

I. Thermostats for ventilation and heating systems shall be Honeywell, Penn, or equal.

2.3 BASIC MATERIALS.

Molded Composite	Exterior and interior resin-fiberglass laminate with foam core.
Fiberglass Laminate	Isophthalic polyester resin and chopped commercial grade E-glass strand fiberglass with a coupling agent that will provide a suitable bond between the glass reinforcement and the resin, with a minimum glass content of 25%.
Exterior Surface	15 mil gel coat with U.V. inhibitors and a satin finish, lightly textured and free from fiber pattern, roughness, or other irregularities.
Exterior Laminate	1/8 inch thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.
Interior Laminate	1/8 inch thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.
Interior Surface	White (#1540) gel coat with satin finish, and free from exposed glass or other irregularities.
Laminate Properties	
Tensile strength (ASTM D 638)	16,000 psi minimum
Flexural strength (ASTM D 790)	33,700 psi minimum

Shear strength (ASTM D 732)	9,000 psi minimum
Barcol hardness (ASTM D 2583)	45
Density / specific gravity (ASTM D 792)	93.6 PCF/1.5
Impact (ASTM D 256)	12 ft lbs/per inch
Surface burning characteristics (ASTM E84)	Flame spread less than 75 smoke density less than 450

Core

Type	Rigid closed cell, self-extinguishing, polyisocyanurate foam with a minimum density of 2.0 pounds per cubic foot. Foam shall be T250 Elfoam.
Minimum Thickness	1.5 inch with a minimum insulating value of R 14.

Properties

Thermal conductivity (ASTM C 518)	0.145 BTU inch/hr./SF/°F
Density / specific gravity (ASTM D 1622)	2.0 PCF / 0.24 minimum
Shear Strength (ASTM C 273)	25 lb/in^2
Tensile Strength (ASTM D 1623)	45 lb/in^2
Compressive Strength (7% deflection/yield) (ASTM D 1621)	35

Surface Burning Characteristics (ASTM E 84)	Flame spread 25, smoke density 240
Service Temperature	- 100 °F to + 250 °F

Anchor Bolts and Nuts.

Stainless steel	Bolts, ASTM F593, Alloy Group 1 or 2; nuts, ASTM F594, Alloy Group 1 or 2.
Flat Washers, Fasteners and Hardware	ANSI B18.22.1; of the same material as anchor bolts and nuts.304 Stainless Steel, B8 Class 1 or 2 Bolts with suitable A194 Grade 8 nuts and washers.

The manufacturer shall maintain a continuous quality control program and upon request shall furnish to the Engineer certified test results of the physical properties.

2.4 ACCEPTABLE MANUFACTURERS.

A. The enclosure shall be as manufactured by Plasti-Fab, Warminister, Shelter Works, Tracom, or equal.

2.5 COMPONENTS.

A. Door.

1. One-piece, resin transfer molded (RTM) in matched metal molds to produce an industrial quality door, which exhibits a smooth finished, seamless, monolithic, warp-free composite consisting of a gel-coat, fiberglass reinforcement, polyester resin, insulating core, and internal reinforcements with all mortises, openings, recesses, and pockets molded in place. Door size shall be minimum 3 ft wide by 6’-8” ft tall for single doors and the thickness shall be a minimum of 1-3/4 inches.

2. The doors shall be insulated with 1-1/2 inch thick polyurethane foam and have a smooth white gelcoat finish, the same as the enclosure's exterior walls and roof. The doors shall be able to open 180 degrees and shall have closer hardware with hold-open or tie-back. The door frames shall be integrally molded into the enclosure's walls. The doors shall be supplied with the following items:

   a. Continuous stainless steel piano hinge.
   b. Neoprene door seal gasket.
   c. Neoprene base wiper gasket.
   d. Glass vision window (approximately 12” x 12”).
   e. Panic hardware.
   f. Lockset to match Owner standard equipment.

3. All door hardware and fasteners shall be of non-corroding material.

B. Base Mounting Flange.

1. Paneled buildings: Provide wall panels with an integral 4 inch wide mounting flange with pre-drilled holes for attaching to the floor. Spacing and size of holes to be determined by building manufacturer.

2. One- or two- piece buildings: integral 4 inch wide mounting flange around the perimeter with pre-drilled holes for attaching to the floor. Spacing and size of holes to be determined by building manufacturer.

C. Base Mounting Flange Gasket. 1/4 inch thick by 3 inches wide with closed cell neoprene sponge rubber gasket 3/8 inch thick by 2 inches wide to provide a weather tight seal around the building perimeter.

D. Anchor Bolts For Attaching Structure To Concrete Pad.

1. Paneled buildings: stainless steel expansion anchors, size to be determined by building manufacturer.

2. One- or two-piece buildings: stainless steel expansion anchors, size to be determined by building manufacturer.

E. Lifting Eye Bolts. Provide 3/4 inch minimum stainless steel eye bolts in roof.

F. Plumbing Vent Flashing. Provide roof flashing as required for plumbing and other equipment vent penetrations at locations as indicated on plans.

G. Floors. Concrete pad floor with non-slip finish. .

2.6 ELECTRICAL.

A. Cable, conduit, boxes, and fittings shall meet requirements of the Electrical section of the specifications.

B. Lighting

1. The lighting arrangement shall be designed by the enclosure manufacturer and approved by the Engineer. Lighting design shall adhere to all applicable codes and standards, as required. The lighting design shall meet the following minimum requirements:

a. Interior of the enclosures shall have a minimum average of 30ft candles per square foot.
b. Interior lights shall be LED.
c. Interior lighting calculations shall be provided in the submittal showing the calculated light distribution as designed

d. All interior lights shall be controlled by a single light switch located adjacent to the door
e. Exterior lights shall be LED and mounted where indicated on the Drawings. Lights shall be activated when both a photocell senses dark and a motion sensor is activated.
f. Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I" shall meet the requirements in 260511.
g. The enclosure manufacturer shall pre-wire the lighting circuits to lighting panel and shall coordinate power requirements with electrical contractor.

C. Wall Switches.

1. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".

D. Receptacles.

1. Two ground fault circuit interrupter three-wire grounding receptacle shall be provided inside and outside the building enclosure near the enclosure doorway. The outdoor receptacle shall be weatherproof.

2. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Hubbell "GF5362I" or Leviton "7899-I".

3. The enclosure manufacturer shall pre-wire the receptacle circuits to lighting panel and shall coordinate power requirements with the electrical contractor.

E. Lighting Panel.

1. The lighting panel shall be a dead-front, 120/208 volt, 100A bus, three phase panelboard with circuit breakers, in accordance with the following:

F. Cabinet

1. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

G. Circuit Breakers

1. Main circuit breaker shall be 3-pole, 50A maximum with a minimum of 15 branch circuits.

2. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole

shall be common trip. Breakers shall have interrupting ratings not less than 22,000amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Drawings.

H. Buses

1. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.7 EQUIPMENT.

A. All additional equipment and materials required for proper installation and operation but not specified elsewhere shall be furnished and installed by the enclosure manufacturer.

B. Equipment mounting:

1. Contractor shall coordinate with building manufacturer on precise panel and equipment sizes and locations.

2.8 FINISHES.

A. The finish exterior and interior enclosure colors shall be selected by Owner from manufacturer’s standard color selection charts.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the structure. The Contractor shall correct all deficiencies before proceeding.

B. Installation of the FRP enclosure shall be in accordance with the enclosure manufacturer’s instructions. Anchor bolts shall be set in accordance with the anchor bolt setting plan of the enclosure manufacturer. Installation shall require only anchoring and sealing of the enclosure to the base structure, and the connection of electrical power and piping.

C. The HVAC equipment, and building components (lighting, wall switches, receptacles, lighting transformer, lighting panel, and associated cabling and conduit) shall be factory installed.

D. All equipment (except heaters and exhaust fans with associated dampers and controls, lighting fixtures and switches, receptacles, motor starters, lighting transformer, lighting panel, and cabling and conduit for circuits serving lighting fixtures, receptacles, heaters and vent fans) to be located within the enclosure shall be field installed after the enclosure is erected and shall conform to the requirements of the Electrical section.

E. All panels, pumps, piping, etc shall be installed on fiberglass unistrut support systems with stainless steel hardware, supported on the floor or walls of the Building. Aluminum or stainless steel unistrut support systems may be used as alternatives only in the building enclosure for added strength to support equipment. No panels, pumps, piping, etc installed by the Contractor shall be mounted to the walls of the fiberglass enclosure.

F. Building manufacturer shall provide an equipment mounting panel to support the instrument indicating transmitters.

3.2 FIELD TESTING.

A. The building shall be leak tested with a garden hose prior to acceptance. Any leakage discovered shall be corrected and retested.

3.3 PROTECTION.

A. All portions of the building shall be protected from damage during site storage and erection. Damaged parts shall be replaced with undamaged units unless field repairs are authorized by Engineer.

3.4 CLEANING.

A. After completion of construction all soiled surfaces shall be cleaned in accordance with the manufacturer's instructions.

End of Section

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SECTION 21 13 00 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of materials, equipment, and appurtenances associated with wet-pipe fire sprinkler system. All labor, materials, tools, equipment, service and supervision required to design, install, test, and place the fire sprinkler systems in service shall be provided.

B. Fire sprinkler systems shall meet the design conditions and features and as indicated on the drawings. All required piping, valves and appurtenances are not indicated on the drawings but shall be provided for a complete system compliant with the requirements indicated herein.

C. Provide automatic wet sprinkler system for Chemical Building chemical storage room in the Bridgeport Utilities Wastewater Treatment Plant (WWTP). The system shall be designed to discharge at least 0.2 gpm/ft^2 density for chemical storage room and meet ordinary hazard group II classification and NFPA 13 requirements.

D. Provide approved backflow preventer assembly upstream of sprinkler valve station in Building.

E. Provide wall type post indicator valve upstream of sprinkler valve station in Building to be operated from exterior of the building.

F. Provide 24 VDC weatherproof horn strobes on top of fire department connections for the sprinkler system. Sprinkler system flow alarms will be controlled and monitored by fire alarm control panel provided by Section 28 31 19 – Fire Protection and Signaling System.

G. Provide valve supervisory tamper switches for all water supply control valves provided as part of sprinkler system. Valve supervisory switches and sprinkler system will be monitored by fire alarm control panel provided by Section 28 31 19 – Fire Protection and Signaling System.

1.2 GENERAL

A. Coordination

1. Piping, equipment, and appurtenances furnished and installed under this section shall be designed, fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations furnished by the manufacturer unless exceptions are noted by Engineer.

2. Contractor shall verify that each component of the fire sprinkler system is compatible with all other parts of the system; that all piping, equipment, and appurtenances are appropriate

for the intended function; and that all devices necessary for a properly functioning system have been provided.

3. Equipment and appurtenances furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the products of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

4. Contractor shall coordinate with the electrical contractor to make certain that the field wiring associated with this section is complete in accordance with the requirements of the equipment specified herein. Contractor shall coordinate the wiring of alarm devices to the equipment furnished and installed under the Fire Detection and Alarm System section.

5. Contractor shall become familiar with details of the work, shall verify dimensions in the field, and notify Engineer of any discrepancy before performing the work.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with the applicable national, state, and local codes and ordinances, laws, regulations, and NFPA Standards which pertain to such work. In case of a conflict between these specifications and any applicable national, state, or local code, ordinance, law, regulation, or NFPA Standard, the latter shall govern.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming a part of the equipment and appurtenances furnished, shall be submitted in accordance with the Submittals Procedures section.

2. The submittal to Engineer shall be made after the local authorities having jurisdiction have approved the design.

3. The data and specifications submitted shall include, but not be limited to, the following:

Design Documents

Complete working plans, hydraulic calculations, water supply data, and information required by NFPA Standards.

Hydraulic design placard.

Equipment, Piping, and Appurtenances

Name of manufacturer

Type and model

Construction materials, thickness, and finishes

Capacities

Pressure and temperature ratings

Overall dimensions

Piping connection type, size, and location

Wiring diagrams

Pressure loss data

Net weight

Test Reports

Test reports and certificates as described in NFPA Standard 13.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

1.4 QUALITY ASSURANCE

A. All materials and work shall conform to the requirements of the National Fire Protection Association (NFPA), Factory Mutual (FM), and Underwriters' Laboratories (UL).

B. Manufacturers providing equipment and appurtenances shall be listed by product name and manufacturer in the UL Fire Protection Equipment Directory and FM Approval Guide.

C. Fire sprinkler system materials shall be permanently stamped or labeled with the listing and approval agency's identification.

D. Materials, installation, inspection, and testing of the fire sprinkler system shall comply with the requirements of the local authorities having jurisdiction and Owner's insurance underwriter.

E. The sprinkler system drawings and calculations shall be performed by an individual who has National Institute for Certification of Engineering Technologies (NICET) III certification in the subfield of automatic sprinkler design and signed and sealed by a registered professional engineer licensed in the state in which the project is located.

F. The fire sprinkler system shall be installed by a firm having previously installed a minimum of five systems similar in size and scope to this project.

1.5 PERFORMANCE AND DESIGN REQUIREMENTS

A. All piping, equipment, and appurtenances shall be designed to meet the performance and design conditions as specified herein and on the Drawings. The system shall be designed as an automatic wet-pipe sprinkler system as indicated in Schedule 21 13 00 S01. The system type, zoning, hazard classification, sprinkler density, and design area of operation shall be as indicated on the Schedule 21 13 00 S01.

B. The design area represents the minimum area to be considered for hydraulic calculations. The system shall be designed to discharge the sprinkler density over the most hydraulically demanding design area. The area required to be sprinkled may be larger than the design area.

C. Water allowances shall be made for outside hose streams. Hose stream flow rates shall be as specified by NFPA Standards.

D. Flow Test

1. The sprinkler system shall be designed using data from a water flow test performed by the Contractor.

2. The water flow test is to verify that adequate pressure is available at the required flow before the system is designed. If it is not possible to perform a flow test prior to designing the system, the test may be performed later, however, Contractor shall accept responsibility for any modifications required in the event that the flow tests indicate a lower available water supply than that on which the calculations were based.

3. Contractor shall verify water supply data prior to designing the sprinkler system.

E. Pipe Sizing

1. The sprinkler system shall be hydraulically calculated, and shall include a safety factor of 10 psig at the design flow.

2. Pipe and accessory sizes indicated on the Drawings are the minimum allowed, and shall be increased if determined necessary by hydraulic calculations. The water velocity in piping systems shall not exceed 20 fps at design flow.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.7 EXTRA MATERIALS

A. A supply of spare sprinklers shall be provided in accordance with NFPA Standard 13. The sprinklers and sprinkler wrench shall be stored in a suitable metal container and shall be representative of the number of each type and each temperature rating of the sprinklers installed.

B. Extra materials shall be packaged with labels indicating the contents of each package. Each label shall include the manufacturer's name, equipment identification, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All components of the fire sprinkler system shall be designed to meet the specified conditions.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as indicated in the respective product description paragraphs.

2.3 MATERIALS

A. All piping systems and related components shall be rated for at least 175 psig working pressure.

B. Anchor Bolts and Expansion Anchors

1. All anchor bolts, expansion anchors, nuts and washers shall comply with UL, FM, and NFPA requirements. Powder-driven anchor assemblies shall not be used.

C. Piping Systems

1. Piping on the supply side of the backflow prevention device shall be as specified in other sections for potable water use. Piping on the sprinkler side of the backflow prevention device shall be black or galvanized steel pipe as follows:

All 2 inch and smaller piping: Schedule 40, ASTM A53 with Threaded Malleable or Cast Iron Fittings.

All 2-1/2 inch and larger piping: Schedule 40, ASTM A53 with Flanged Fittings.

All 2-1/2 inch and larger piping on the sprinkler side of the backflow preventer. (optional): Schedule 40, ASTM A53 with Grooved-End Fittings.

All 2-1/2 inch and larger piping on the sprinkler side of the backflow preventer. (optional): Schedule 40, ASTM A135 with Roll-Grooved Fittings.

2. Galvanized steel pipe shall be used for sprinkler piping in chemical feed and storage rooms.

3. Pipe shall be furnished complete with all fittings, jointing materials, supports and anchors, and other accessories required for a complete system.

4. Plain-end fittings with mechanical devices which grip into the pipe, and saddle type branch fittings shall not be used.

D. Pipe Supports

1. Pipe supports shall be suitable for the application, construction, and type and size of pipe used.

2. “C” type clamps shall be provided with retaining clips and shall not be used for piping larger than 3 inch [75 mm] size.

3. Galvanized hanger assemblies shall be used for the support of galvanized steel piping systems.

E. Service Valves

1. Service valves shall be UL-listed and FM approved, with 175 psig non-shock minimum working pressure rating.

F. Gate Valves

1. Gate valves in 2 inch and smaller sizes shall be cast-bronze with threaded ends, solid wedge disc, outside screw and yoke, and rising stem.

2. Gate valves in 2-1/2 inch and larger sizes shall be iron body, bronze mounted, with tapered solid wedge disc, outside screw and yoke, and rising stem. Valves shall be provided with replaceable bronze disc facing rings and flanged ends.

3. Gate valves in 4 inch and larger sizes for use with indicator posts shall be iron body, bronze mounted, with solid wedge disc, non-rising stem, operating nut, replaceable bronze disc facing rings, and bonnet cap for indicator post.

4. Indicator posts shall be wall type with cast-iron body, windows for target plates that indicate valve position, extension rod and coupling, locking device, hand wheel operator, wall flange, and red enamel finish. Gate valves for use with wall indicator posts shall be provided with flanged ends.

5. Indicator posts shall be provided with a supervisory switch to alarm when the valve is not in the full open position.

G. Butterfly Valves

1. Not allowed.

H. Ball Valves

1. Ball valves in 2 inch and smaller sizes shall be brass ball and body with reinforced Teflon seat and threaded ends.

I. Check Valves

1. Swing check valves 2-1/2 inch and larger shall be cast-iron body with bolted cap, bronze disc or cast-iron disc with bronze disc ring, and flanged ends.

J. Specialty Valves

1. Specialty valves shall be UL-listed and FM approved, with 175 psig non-shock minimum working pressure rating.

2. Alarm Check Valve

a. Alarm check valves shall be provided with variable pressure trim and standard accessories including pressure gauges; alarm switch with contacts rated for 120 volts, 10 amperes; testing bypass; drain cup; retarding chamber; and all necessary pipe, fittings, and accessories required for a complete trimming installation in accordance with NFPA No. 13. The valve shall be provided with flanged inlet and outlet, bronze grooved seat with O-ring seals, and single hinge pin and latch design. The alarm switch shall be wired to the fire alarm system.

3. Deluge-Pipe Valve

a. Not used.

4. Air Maintenance Device

a. Not used.

5. Dry-Pipe Valve

a. Not used.

6. Air Maintenance Device

a. Not used.

7. Ball Drip Valves

a. Ball drip valves shall be automatic drain type, 3/4 inch body size, with spring-loaded ball check device and threaded ends.

8. Backflow Preventer

a. The sprinkler system backflow preventer shall be of a type as approved by local authority having jurisdiction. The unit body shall be epoxy-coated cast iron or stainless steel. Gate valves with flanged ends, outside screw and yoke, rising stem, and resilient seats shall be factory installed at each end of the unit. Each gate valve shall be provided with a supervisory switch to alarm in the event that the valve is not in the full open position.

b. Detector type backflow preventers shall have a bypass consisting of a bronze displacement type water meter in series with a bronze backflow preventer with ball valves on the bypass line. The backflow preventer on the bypass line shall be double check or reduced pressure principle type as needed to match the primary unit. Backflow preventers shall be as manufactured by Febco, Watts Industries, Inc., or Ames.

K. Automatic Sprinklers

1. Sprinklers shall be furnished and installed in accordance with their listed spacing limitations. Automatic sprinklers shall be provided with heat responsive elements conforming to UL 199. Sprinkler types and categories shall be as indicated in Schedule 21 13 00 S01. Sprinklers shall be provided with nominal 1/2-inch orifice and 165° F temperature rating unless otherwise indicated or required by application. Sprinklers located in the vicinity of heaters shall be provided with intermediate or high temperature ratings as specified by NFPA 13.

2. Sprinklers shall be furnished and installed with all required escutcheons for a complete installation. Escutcheons shall permit sprinkler head adjustment as needed for a proper installation.

3. Sprinkler cabinets shall be of finished steel, with hinged cover, space for minimum of six spare sprinklers plus sprinkler wrench, and shall be suitable for wall mounting. The number of sprinklers required by NFPA 13 and 1 wrench for sprinklers shall be included. A separate cabinet with sprinklers and wrench shall be provided for each style of sprinkler on this project.

4. When indicated in Schedule 21 13 00 S01, wire-cage type sprinkler guards shall be provided with fastening device for attaching to sprinkler.

L. Fire Department Connection

1. A sprinkler system fire department siamese connection shall be provided. The location of the connection shall be as indicated on the Drawings and as approved by Engineer and the local authority having jurisdiction.

2. The siamese connection shall be a projecting wall-type, with cast-brass body; polished chrome plated finish; NH-standard thread inlets according to NFPA 1963 and matching

local fire department threads; and threaded NPS outlet. Connection shall include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; and round wall escutcheon plate with marking "AUTO SPKR." The connection shall be provided with two 2-1/2 inch inlets and one 4 inch back outlet.

M. Alarm Devices

1. Alarm devices shall be provided. Alarm device type and size shall be as needed to match piping and equipment connections.

2. Water flow indicators shall be electrical supervision vane type, rated to 250 psig, and shall comply with UL 346. The indicators shall be furnished with a pipe saddle and cast aluminum housing, and shall be suitable for horizontal or vertical installation. Two isolated spdt alarm contacts shall be provided. Contacts shall be rated for 7 ampere, 125 volts ac and 0.25 ampere, 24 volts ac. Water flow indicators shall be complete with factory-set, field-adjustable, instantly recycling pneumatic retard element to prevent false signals, and tamper-proof cover that alarms when cover is removed.

3. Pressure switches shall be electrical supervision type, with spdt contacts, and shall comply with UL 753. The pressure switches shall be designed to signal water flow based on rising pressure.

4. Supervisory (tamper) switches shall comply with UL 753, and shall be electrical supervision type, with spdt normally closed contacts. The switches shall be designed to signal when the controlled valve is in other than the fully open position and when the switch is removed or dismantled.

5. Water flow alarms shall be electric audible and visual type and shall be compliant with NFPA Standard 72 and UL Standard 1638. The alarm shall be weatherproof, and shall be suitable for a 24 volts dc power supply to be compatible with the fire alarm system. The alarm shall be initiated by the flow through the alarm check valve retarding chamber or water flow switch.

N. Air Compressor

1. Not used.

O. Pressure Gauges

1. Pressure gauges shall comply with UL 393, and shall be provided with 3-1/2 inch to 4-1/2 inch diameter dial, and a dial range of 0-250 psig.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall field verify all existing conditions prior to designing the system.

3.2 INSTALLATION

A. Piping, equipment, and appurtenances furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. A metal placard with the hydraulic design information shall be attached with a stainless steel chain to each sprinkler riser. Each placard shall contain the system design information as required by NFPA 13.

C. Sprinkler Piping and Accessories

1. Deviations from approved “working plans” for sprinkler piping require recalculation and approval by authority with jurisdiction. Written approval shall be obtained from Engineer prior to deviating from approved “working plans.”

2. Approved fittings shall be used to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Unions shall be installed adjacent to each valve in pipes 2 inch and smaller. All piping shall be hidden from view in areas with finished ceilings unless accepted by Engineer to be exposed.

3. “Inspector’s Test Connections” shall be installed in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

4. The sprinkler piping shall be installed with drains for complete system drainage. Ball drip valves shall be installed to drain piping between fire department connections and check valves, and where indicated. Drains shall be routed to outside the building unless otherwise indicated on the Drawings.

5. The sprinkler head riser drop lengths shall be determined in the field and shall be coordinated with all ductwork, electrical conduit, piping systems, process equipment, and tanks. If the sprinkler system piping is installed before all ductwork or other building system construction is finished and if any sprinkler head risers need to be relocated to meet the code requirements, Contractor shall extend or relocate the risers and sprinkler heads at his expense.

6. Hanger and support spacing and locations for steel piping joined with grooved mechanical couplings shall be in accordance with the manufacturer’s written instructions for rigid systems.

7. Metal roof decking shall not be used for the support of equipment or piping.

8. Piping shall be installed in accordance with NFPA 13 to protect from earthquake damage.

9. Pressure gauges shall be installed at each sprinkler test connection and at top of each riser. Pressure gauges shall be provided with connections not less than 1/4 inch and with soft metal seated globe valve arranged for draining pipe between gage and valve. Gauges shall be installed to permit removal and shall not be installed where subject to freezing.

10. All alarm devices shall be connected to the fire alarm system.

11. The electric sprinkler flow alarm shall be mounted outside on an exterior wall of the building at a location suitable to Engineer so personnel in the area will notified when an alarm is sounded.

D. Sprinkler Valves

1. Fire sprinkler valves shall be installed with all trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions and the requirements of the authority having jurisdiction.

2. Service valves shall be supervised-open, and located to control sources of water supply except from fire department connections. Permanently marked identification signs indicating portion of system controlled by each valve shall be provided.

3. Alarm check valves shall be installed in the vertical position for proper direction of flow, including bypass check valve and retard chamber drain line connection.

4. Double-check detector assembly backflow preventers shall be installed with bypass water meter, gate valves on each side of meter, and check valve downstream from the meter.

3.3 FIELD TESTING

A. Field testing of the fire sprinkler systems shall conform to NFPA Standard 13 "System Acceptance" Chapter and to the requirements of the local Fire Department.

B. The Engineer and the local authority having jurisdiction will witness all tests. Contractor shall arrange the testing schedule with the local authority having jurisdiction and the Engineer; with at least 7 days' advance notice.

C. Contractor shall replace piping and components that do not pass the test procedures specified, and then retest to demonstrate compliance. The procedure shall be repeated until satisfactory results are obtained at no additional cost to Owner. Three copies of test reports shall be submitted in writing to Engineer and to the authority having jurisdiction.

D. Test certificates shall be executed and submitted prior to final inspection and acceptance in accordance with NFPA Standard 13. Three copies of each test certificate shall be furnished to Engineer and the authority having jurisdiction.

E. After installation and testing of the fire suppression system, complete drawings, conforming to installation records, including location of sprinkler heads, control valves, water supply connections, and wiring diagrams, shall be submitted to Engineer prior to final acceptance.

3.4 ADJUSTING

A. All alarm devices shall be adjusted for proper operation. All drains shall be checked for proper operation.

3.5 CLEANING

A. Immediately prior to the final inspection, equipment, piping and appurtenances shall be thoroughly cleaned. Dirt and debris shall be cleaned from sprinklers. Sprinklers having paint other than factory finish shall be replaced with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.6 FINAL INSPECTION AND ACCEPTANCE

A. A decision shall be reached during the inspection concerning the resolution of discrepancies and changes as recommended by the authorities having jurisdiction. All work determined to be the responsibility of Contractor, and included within the scope of the specifications, shall be promptly completed at no expense to Owner.

B. The final acceptance of the fire sprinkler system shall be made after the completion of the corrective work resulting from the final testing and inspection and after receipt of a formal letter of acceptance from the authority having jurisdiction.

End of Section

Schedule 21 13 00 S01

Fire Sprinkler Systems

Performance and Design Requirements					
Zone	Area Or Rooms To Be Sprinkled	System Type	Hazard Classification	Sprinkler Density gpm/sq ft	Design Area sq ft
1	Chemical Building WWTP Chemical Room	Wet	OH2	0.2	3,000

Sprinkler Requirements			
Area	Sprinkler Type	Sprinkler Finish	Remarks
Unfinished areas without ceilings	Upright	Rough brass	
Finished areas without ceilings	Upright	Polished chrome plated	
Finished areas with ceilings	Pendent	Polished chrome plated	
Chemical feed and storage areas	Upright	Corrosion-resistant	
Electrical and mechanical rooms	Upright	Rough brass	1,2

Remarks:

1. Sprinkler shall have 212° F temperature rating.
2. Sprinkler guard required.

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SECTION **22 00 00** - PLUMBING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated on the Drawings. Additional requirements for plumbing systems shall be as indicated in the schedules on the Drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

B. Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1.2 GENERAL

A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

3. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

F. Power Supply

1. Unless otherwise specified, power supply to equipment with motors shall be as indicated on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

G. Metal Thickness

1. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

H. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Net weight.

Horsepower [kW].

Power requirements.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Water consumption data.

Overall dimensions.

Rough-in dimensions.

Piping connection sizes and locations.

Net weight.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operations and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

2. Operation and maintenance manuals are required for water heaters, circulating pumps, and expansion tanks,

1.4 QUALITY ASSURANCE

A. Welding Qualifications

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer’s review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

B. Qualification

1. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Manufacturer's Experience

1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

D. Construction

1. Plumbing fixtures shall be constructed in accordance with the following standards:

Emergency/Safety Fixtures	ANSI Z358.1

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as required, in the quantities indicated below.

Part	Number Required
Water heater relief valves	1 per heater

B. Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

1. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

B. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION

A. Anchor Bolts and Expansion Anchors

1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage In Concrete and Masonry section unless otherwise indicated on the Drawings.

B. Surface Preparation

1. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

C. Shop Painting

1. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

2. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

3. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Protective Coatings section.

D. Equipment Bases

1. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

E. Special Tools and Accessories

1. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

F. Piping Systems

1. Unless otherwise specified herein, piping system materials shall be as specified in other sections.

G. Valves

1. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall be as specified in other sections.

2.5 WATER SUPPLY PIPING ACCESSORIES

A. Water Hammer Arresters

1. Water hammer arresters shall be either bellows or piston type. Bellows type arresters shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arresters shall be rated for a maximum working pressure of 350 psig and a temperature range of 33° F to 250° F . Water hammer arresters shall be Smith “Hydrotrol,” Josam “75000 Series Absorbotron,” Wade “Shokstop,” or Sioux Chief “Hydra-Rester.”

B. Trap Primers

1. Pressure Activated Trap Primers

    a. Pressure activated trap primer valves shall be the automatic type activated by pressure drop in a pipeline. The primer valve shall consist of a brass body with removable operating parts and an integral air gap. A distribution unit shall be provided when a single primer valve serves multiple traps. The trap primer shall be self-adjusting to line pressure and shall not require field adjustment. Connections shall be 1/2 inch NPT. Trap primer valves shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1018. Trap primer valves shall be Precision Plumbing Products Prime-Rite "PR-500," MIFAB "M-500," or Sioux Chief "695 Series."

2. Electronic Trap Priming Panel

    a. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol "TPP" and an identifying number. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations. Electronic trap priming panels shall consist of a panel, timer, 120 V solenoid, calibrated manifold system and shall be manufactured by Precision Plumbing Products Inc. "PTS Series," Zurn, MIFAB, or equal. Reference the plumbing drawings for the number of priming tubes required per trap priming panel.

C. Vacuum Relief Valves

1. Vacuum relief valves shall have bronze or brass bodies rated for 200 psig and shall be provided with male threaded inlet connections. The valves shall open at 1/2 inch water column vacuum and shall have a venting capacity of at least 15 cubic feet per minute. Vacuum relief valves shall be Watts Regulator "Model LFN36," Cash Acme "VR-801," or Apollo Valves "Model VR."

D. Thermometers

1. Thermometers shall be Weksler Instruments "Adjust Angle," Ashcroft "Series EI Everyangle" or Weiss Instruments, Inc. "Vari-angle."

2. Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

3. Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200° F .

4. Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch NPT thread mounts, a minimum pressure rating of 250 psig , and a nominal 4 inch insertion length.

E. Strainers

1. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated. The blowoff from each strainer shall be equipped with a shutoff valve.

2. Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens. Strainers shall be Watts "Series LF777SI," Apollo Valves "Model YB-LF" or Wilkins "Model YBXL."

F. Hose Faucets

1. Hose faucets shall be constructed with nickel or chrome plated cast brass body, solid brass stem, threaded bonnet, and "T" style handle. Hose faucets shall be provided with a 3/4 inch male pipe thread inlet and a 3/4 inch male hose thread outlet unless otherwise indicated on the Drawings. Hose faucets shall be Prier Brass "Model C-138NP.75," Arrowhead Brass Products, or Zurn.

G. Wall Hydrants

1. Wall hydrants shall be freezeproof type with bronze body, polished bronze or chrome plated face, integral vacuum breaker, and removable handle key. Wall hydrants shall be provided with 3/4 inch pipe thread inlet and 3/4 inch male hose thread outlet. Wall hydrants shall be ASSE 1019-B approved. Wall hydrants shall be Smith "Model 5619," Zurn "Z1321-C," or Prier "Model C-634."

H. Pressure Gauges

1. Pressure gauges shall be Ashcroft "Duragauge 1279," Weksler, or Weiss Instruments, Inc.

2. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

3. The dial shall be 4-1/2 inch in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.

4. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.

5. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.

6. Diaphragm Seals

a. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings. Diaphragm seals shall be thread-attached type with cleanout ANSI Type 316 stainless steel diaphragm, plated carbon steel upper housing, and stainless steel lower housing. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge failure or removal from the system under pressure. The lower housing shall be provided with a tapped 1/4 inch NPT flushing connection and an MxF stainless steel needle valve. Each gauge isolator and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

b. Gauge isolators shall be as manufactured by Ashcroft "Type 101," Weksler, or Weiss Instruments, Inc.

I. Insert other accessories required

2.6 DRAINAGE AND VENT PIPING ACCESSORIES

A. Cleanouts

1. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes, and shall be of the required type.

2. Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

3. Cast iron cleanouts shall be manufactured by Smith, Josam, or Wade.

B. Funnel Receptors

1. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch above the finished floor.

2. Funnel receptors shall be Smith "Series 3800," Josam, or Wade.

C. Floor Drains

1. Floor drains shall be of the types specified herein and indicated on the Drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains

installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

2. Cast iron floor drains shall be manufactured by Smith, Josam, or Wade.

D. Vent Flashings

1. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

2.7 PLUMBING FIXTURES AND ACCESSORIES

A. General

1. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

B. Emergency Fixtures

1. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed as indicated on the Drawings. Emergency fixtures shall be manufactured by Haws, Guardian, or Encon.

2. Corrosion Resistant Combination Units

a. Corrosion resistant combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with 2-1/2 inch schedule 80 PVC stanchion, floor flange, deluge shower, aerated eye/face wash, eye/face wash dust cover, stay-open stainless steel ball valves, interconnecting piping, and universal emergency sign. The shower shall be stainless steel or ABS plastic with stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel or plastic with push plate actuator.

3. Freezeproof Emergency Eyewash Fixtures

a. Freezeproof emergency eye wash fixtures shall be wall mounted with a wall bracket, a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, and a universal emergency sign. The ball valve shall be located indoors, with an extension stem extending through the exterior wall to the push plate actuator. All necessary drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

4. Freezeproof Emergency Shower Fixtures

a. Freezeproof emergency shower fixtures shall be wall mounted, suitable for a horizontal supply pipe, with a pipe support bracket, a stainless steel or ABS shower head, a stay-open ball valve, and a universal emergency sign. The ball valve shall be located indoors, with an actuator extending through the exterior wall. All drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

5. Alarm Systems

   a. An audible and visual alarm system shall be provided when indicated on the Drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The alarm system shall provide local, remote, or local and remote alarm indication as indicated on the Drawings. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

6. Tempered Water Blending Valves

   a. Tempered water blending valves shall be designed specifically for providing tempered water to emergency shower and eyewash fixtures. Each valve shall contain thermostatic elements, integral cold water bypass, and positive hot water shutoff to prevent scalding. Blending valves shall have bronze or brass bodies with threaded inlet and outlet connections and shall be provided with isolation check valves on the hot and cold supplies to the unit. Each unit shall include hot, cold, and blended water temperature gauges and shall be factory set for a blended water temperature of 70° F.
   b. Tempered water blending valves serving eyewash fixtures, a single shower, or a single combination unit shall be suitable for a flow range of 3 to 25 gallons per minute and shall be Haws "Model 9201," Guardian "G3700," or Lawler "Model 911E. Tempered water blending valves serving multiple showers or multiple combination units shall be suitable for a flow range of 3 to 60 gallons per minute and shall be Haws "Model 9202," Guardian "G3900" or Lawler "Model 911."

2.8 PLUMBING EQUIPMENT

A. General

1. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

B. Water Heaters and Accessories

1. Water heaters shall be furnished and installed where indicated on the Drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated on the Drawings.

2. Commercial Grade Gas-Fired Water Heaters

a. Gas-fired water heaters shall be commercial, storage type, with a glass-lined tank and a natural or propane gas burner as indicated on the Drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, a flue damper, and an adjustable thermostat. The heater burner shall be atmospheric type, constructed of aluminized steel, and shall be suitable for a minimum gas supply pressure as indicated on the Drawings. The burner shall be provided with a gas pressure regulator, a manual reset safety shutoff, and an intermittent electronic ignition control system. Burner operation shall be interlocked with the flue damper to prevent burner and pilot ignition until the flue damper is proven open. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig . Heater tanks larger than 70 gallons shall be provided with an inspection port. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The water heaters shall be manufactured by A. O. Smith, State Industries or Lockinvar.

3. Water Heater Flues

a. A complete flue system shall be provided for each gas-fired water heater. Unless otherwise required to maintain the listing of the heater, water heaters utilizing atmospheric burners or fan assisted heaters which operate under a negative flue pressure shall be provided with a Type ‘B’ flue system. Water heaters utilizing forced draft burners which pressurize the flue shall be provided with a pressurized flue system. Metal flues shall be as specified in the Heating, Ventilating, and Air Conditioning sections.

b. For applications where under normal conditions the flue gas is expected to be condensing in the flue, and when recommended by the water heater manufacturer, flues shall be schedule 40 PVC pipe with drain, waste, vent (DWV) fittings.

4. Circulating Pump

a. A circulating pump shall be furnished and installed where indicated on the Drawings. Pump capacity, power requirements, manufacturer, and model shall be as indicated on the Drawings.

b. The circulating pump shall be an in-line unit with a NSF 372 certified stainless steel body, stainless steel fitted, mechanical seals, a stainless steel shaft, and at least 1/2 inch 13 mm NPT connections. The circulating pump shall be controlled by a 7-day time clock provided with the pump. Circulating pump shall be programmed to operate continuously, 24 hours a day, regardless of time-based schedules to ensure uninterrupted hot water circulation, always maintaining system readiness and compliance with emergency requirements. The time clock shall be suitable for a 120 volt single phase power supply, and shall have contacts rated for 10 amperes ac. The circulating pump shall be manufactured by Bell & Gossett, Thrush, or Taco.

C. Expansion Tanks

1. Expansion tank capacities, connections, manufacturer, and model shall be as indicated on the Drawings.

2. Expansion tanks shall be welded steel diaphragm type, ASME tested and stamped for a working pressure of 125 psig , with a flexible diaphragm and a charging valve. Floor-mounted tanks shall be provided with a suitable mounting base. The tanks shall be suitable for use with potable water and shall be factory pre-charged to the indicated pressure. Expansion tanks shall be manufactured by Amtrol, State Industries Inc., or Watts.

2.9 COLOR

A. Plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2.10 ELECTRICAL

A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3.3 INSTALLATION

A. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in the Miscellaneous Piping and Accessories Installation section and as indicated on the Drawings.

C. Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

D. Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems.

E. When located indoors, fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building in accordance with the applicable codes and standards.

F. Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

G. Water Supply Piping and Accessories

1. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the Drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

2. Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches of the fixture.

H. Drainage and Vent Piping and Accessories

1. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot ; horizontal sanitary drainage piping larger than 3 inches in diameter shall be installed at a uniform slope of 1/8 inch per foot ; horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot .

2. Plastic drainage pipe buried beneath floors shall not be encased. For buildings supported by piers or piles plastic drainage piping which is buried beneath floors shall be supported with stainless steel pipe supports per ASTM F2536.

3. Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings.

Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

4. Plumbing vents through roofs shall be located at least 12 inches from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

5. Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches above the flood level rim of the fixture served before offsetting horizontally.

6. Floor drains shall be adjusted to the correct elevation for proper drainage. Heads of fastening screws shall be flush with the grate surface.

7. Cleanouts on drainage piping inside structures shall be located where indicated on the Drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in drainage risers shall be located 12 inches above the finished floor.

8. Unless otherwise indicated or required by the applicable code, cleanout size shall equal the line size for 4 inch and smaller drainage piping, and 4 inch in diameter for drains larger than 4 inch . Proper clearance shall be provided for access to cleanouts. Floor cleanouts shall be installed flush with the finished floor.

9. Floor drains, trench drains and funnel receptors indicated to be equipped with traps shall be provided with deep seal “P” traps located as close to the drain as possible.

I. Plumbing Fixtures and Accessories

1. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the Drawings, each fixture shall be mounted at the height recommended by the manufacturer. Where required to be in compliance with ADA, fixtures shall be mounted at the heights established by the Federal Government.

2. Fixtures shall be sealed to the floor or wall with a sealant as specified in the Joint Sealants section. The color of sealant shall match the color of the fixture.

3. Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

4. Water piping at stop valves, shower heads, and flush valves shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

5. Shutoff valves located in the tempered water (TW) supply piping to safety fixtures and shutoff valves in the potable water branch piping to the TW system shall be provided

with tags bearing the legend "WARNING: DO NOT CLOSE VALVE WITHOUT AUTHORIZATION." The tags shall have an orange background and black lettering not less than 1/2 inch in height. Other features of the tags shall be as indicated in the Mechanical Identification paragraph.

J. Plumbing Equipment

1. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

2. Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the Drawings, and shall terminate the appropriate air gap distance above the drain. Unless otherwise indicated, water heater thermostats shall be set such that the maximum water temperature does not exceed 140° F .

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer for commercial grade water heaters shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

B. Startup and Testing

1. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 ADJUSTING

A. All devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3.6 PROTECTION

A. Plumbing fixtures, equipment and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3.7 CLEANING

A. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer.

B. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.8 DISINFECTION

A. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.

2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million [50 mg/L] of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million [200 mg/L] of available chlorine and allowed to stand for 3 hours.

3. The system shall be purged with clean potable water until the chlorine is flushed from the system.

4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

End of Section

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SECTION **22 05 11** - BASIC MECHANICAL BUILDING SYSTEMS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers general mechanical building system requirements as referenced from other sections and furnishing and installation of:

1. Mechanical identification

2. Seismic restraints

3. Special coatings

B. for the plumbing and heating, ventilating, and air conditioning systems. Protective coatings for ductwork and equipment without special coatings shall be as specified in the Protective Coatingssection.

1.2 GENERAL

A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.

B. Coordination

1. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

E. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials furnished, shall be submitted in accordance with the Submittals Procedures section.

Number Plates

Product data on number plates.

A listing of equipment to receive number plates shall be submitted.

Special Coatings

Name of manufacturer.

Coating type.

Color.

Chemical resistance data.

Temperature range data.

Surface preparation.

Application data.

Film thickness per coat.

Drying and curing time information.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Adjustable Frequency Drives

Type and model.

Name of manufacturer.

Operating speed range, rpm.

Rated bhp [kW] at maximum speed.

Efficiency at maximum speed, percent.

Maximum heat output, BTUH [kW].

Speed at maximum heat output, rpm.

Dimensions and net weight of complete panel.

Catalog and data sheets on all components.

Electrical schematics and wiring diagrams.

B. Samples

1. Samples shall be submitted in accordance with the Submittals Procedures section.

2. Samples of color, lettering style, and other graphic representation required for each type of identification material and device shall be submitted.

3. Samples of protectiveand special coatings for equipment shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches [75 mm by 75 mm] in size.

1.4 QUALITY ASSURANCE

A. Welding Qualifications

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer’s review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

B. Manufacturer’s Experience

1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5 EXTRA MATERIALS

A. The following extra materials shall be furnished for the listed equipment:

1. Touchup special coating material

B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

1. Dimensional Restrictions

a. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2. Elevation

a. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

3. Equipment Efficiencies

a. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.

4. Drive Units

a. Drive units shall be designed for 24 hour continuous service.

1) V-Belt Drives
   a) Each V-belt drive shall include a sliding base or other suitable belt tension adjustment. V-belt drives shall have a service factor of at least 1.5 at maximum speed based on the nameplate horsepower of the drive motor unless otherwise indicated in the specific equipment paragraph. Multiple belts shall be provided in matched sets and shall be oil resistant, non-static type. External belts and drive assemblies shall be protected by a belt safety guard constructed in accordance with OSHA requirements. The guard shall be provided with a tachometer opening.
   b) Unless otherwise indicated in the specific equipment paragraph, equipment with smaller than 10 horsepower motors shall have adjustable pitch sheaves and equipment with 10 horsepower and larger motors shall have fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required speed for the specified airflow.
2) Electric Motors
   a) Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.
      1. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the 2007 Energy Independence and Security Act.
      2. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
      3. Rated for continuous duty at 40° C ambient.
      4. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40° C ambient, altitude exceeding 3,300 feet , explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.
      5. To ensure long life, motors shall have nameplate horsepower

[kW] equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp	Open	1.15
	Other Than Open	1.0
Integral hp	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

6. Designed for full voltage starting.
7. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.
8. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.
9. Bearings shall be either oil or grease lubricated.
10. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.
11. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.
12. Totally enclosed motors shall be furnished on:
    (A) Outdoor equipment.
    (B) Equipment for installation below grade.
    (C) Equipment operating in chemical feed and chemical handling locations.
    (D) Equipment operating in wet or dust-laden locations.
13. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.
14. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.

15. Motors used with adjustable frequency drives shall have insulation system meeting the requirements of NEMA MG 1, Part 31.

B. Adjustable Frequency Drives

1. Adjustable frequency drives shall be provided as indicated on the Drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

2.3 MANUFACTURE AND FABRICATION

A. Welding

1. All welds shall be continuous (seal type) on submerged or partially submerged components.

B. Anchor Bolts and Expansion Anchors

1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.

C. Edge Grinding

1. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

D. Surface Preparation

1. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4 MATERIALS

A. Mechanical Identification

1. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.

2. Number Plates

a. Hand-lettered or tape labels will not be acceptable.

b. Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.

3. Piping

a. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.

4. Valves

a. Valve tags shall indicate if the valve is normally open or normally closed.

5. Ductwork

a. Ductwork shall be identified with nameplates as specified herein, or stenciled painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

B. Seismic Design

1. All ductwork and piping associated with the plumbing and HVAC systems shall be provided with seismic restraints in accordance with Seismic Hazard Level (SHL) of the latest edition of the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems as specified and in accordance with the applicable building code. The seismic hazard level used to design the restraints shall be level B. Water heaters shall be restrained in accordance with the applicable plumbing code. Equipment and associated attachments and restraints shall be in accordance with the Meteorological and Seismic Design Criteria section.

C. Special Coatings

1. Where indicated on the Drawings, sheet metal ductwork, dampers, registers, grilles, coils, and equipment shall be given a special coating suitable for the corrosive atmosphere indicated. Sheet metal ductwork, dampers, registers, grilles, coils, and equipment construction shall be suitable to allow proper application of the special coating system in accordance with the manufacturer’s recommendation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer.

B. The installation of identifying devices shall be coordinated with the application of covering materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

End of Section

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SECTION **22 11 19** - BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of backflow preventers and associated appurtenances, as indicated herein. Backflow preventers for fire protection service shall be as specified in the fire sprinklers systems section.

B. Piping, pipe supports, insulation, and accessories which are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to the following:

   a. Name of manufacturer.
   b. Type and model.
   c. Construction materials and finishes.
   d. Net weight.
   e. Unit dimensions.
   f. Performance curves indicating flow capacity versus pressure drop.

B. Operations and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Backflow preventers shall be designed to meet the requirements as indicated herein and in the Backflow Preventer Schedule on the Drawings.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2.3 DESIGN AND CONSTRUCTION

A. Backflow prevention device type shall be as indicated herein.

B. Reduced Pressure Zone Backflow Preventers

1. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Backflow preventers shall comply with the requirements of ANSI/NSF 61 and ANSI/NSF 600, Annex G for low lead. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

2. RPZ backflow preventers in 2 inch and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch and smaller RPZ backflow preventers shall be Febco “Model LF860,” Wilkins “Model 975XL2,” or Watts Regulator “Series LF919.”

C. Hose Connection Vacuum Breakers

1. Hose connection vacuum breakers shall be provided with 3/4 inch hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, manual drain feature, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be Febco "Series 731," Watts Regulator Company "Series 8" or Wilkins "Model BFP 8."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

Backflow Preventer Schedule

Device Number	Location	Size		Max Flow		Max Pressure Drop		Type (1)
		in.	mm	gpm	L/s	psi	kPa	

Notes:

(1) Abbreviations for backflow preventer type:

RPZ Reduced Pressure Zone

SECTION 23 00 00 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, devices, and appurtenances associated with the HVAC systems.

B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

2. Where two or more units of the same class of equipment are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

3. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL safety requirements.

F. Power Supply

1. Power supply to equipment with motors shall be as indicated in schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

G. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

H. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Makeup Air Units
   1) Name of manufacturer.
   2) Type and model.

3) Construction materials, thickness, and finishes.
4) Input and output heating capacities.
5) Filter velocities.
6) Overall dimensions and required clearances.
7) Net weight and load distribution.
8) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds on a single chart.
9) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
10) Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.
11) Electrical requirements including voltage, number of phases, and amperage.
12) Where specified, information on equipment manufacturers' representatives.

b. Positive Pressurization Unit (PPU)
1) Name of manufacturer.
2) Type and model.
3) Construction materials, thickness, and finishes.
4) Filter type, efficiency, and test certificates.
5) Overall dimensions and required clearances.
6) Net weight and load distribution.
7) Wiring diagrams.
8) Where specified, information on equipment manufacturers' representatives.

c. Fans
1) Name of manufacturer.
2) Type and model.
3) Construction materials, thickness, and finishes.
4) Overall dimensions and required clearances.
5) Net weight and load distribution.
6) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.
7) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
8) Where specified, information on equipment manufacturers' representatives.

d. Equipment (not specifically listed)
1) Name of manufacturer.
2) Type and model.

3) Construction materials, thickness, and finishes.
4) Manufacturer's performance data.
5) Overall dimensions and required clearances.
6) Net weight and load distribution.
7) Wiring diagrams.

e. Sheet Metal Ductwork
1) Sheet metal duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.
2) Pressure and seal classifications.
3) Reinforcement types and spacing.
4) Joint and seam types.
5) Hanger and support types, spacing, and attachment methods.
6) Access panel and door construction, sizes, and locations.
7) Duct sealant, adhesive, gasket, and tape information.

f. FRP Ductwork
1) Manufacturer's name. Brand designation/type of duct. Resin manufacturer and type of resin. Pressure, vacuum, and temperature rating.
2) Certification of compliance with referenced standards.
3) Layouts and dimensions of subassemblies to be shipped.
4) Detailed instructions for field butt joints including lay-up sequence, width of each reinforcement layer, and total number of layers.

g. Temperature Controls
1) Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.
2) Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.
3) Sequence of operation for each system corresponding to the control schematics.
4) Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

5) Space thermostat schedule indicating the types of covers and means of adjustment for each space.
6) Conduit and wire types.
7) Where specified, information on equipment manufacturers' representatives.

h. Seismic Design Requirements
1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1.4 QUALITY ASSURANCE

A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

B. The manufacturer of FRP ductwork shall have available a laboratory and quality control facility capable of performing tests and inspections as required by the referenced standards. Material testing, inspection procedures, and manufacturing methods are subject to inspection by the Engineer.

C. The FRP ductwork manufacturer or designated representative shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The FRP ductwork manufacturer's representative shall be on site for at least one 8 hour day, during which they shall observe the assembly of at least three butt joints. The ductwork manufacturer shall submit written certification that the installation contractor's employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the FRP ductwork manufacturer's recommendations and as specified herein. All field butt joints shall be made by representatives of the FRP ductwork manufacturer or by employees of the installation contractor who have been trained and certified by the FRP ductwork manufacturer. Qualified fitters shall carry and have visible at all times a certificate of qualification issued by the FRP ductwork manufacturer. Contractor shall arrange the qualifying training.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

B. FRP ductwork and fittings shall be properly supported to avoid damage caused by flexural strains. Pipe and fittings shall not be thrown or dropped.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

B. Gas fired equipment shall be suitable for operation with the gas inlet pressure range specified in the individual equipment paragraphs.

C. Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

E. Elevation

1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

A. Gas Vent Systems

1. Gas vent systems shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Gas vent system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions and to any local codes which pertain to such work.

2. Factory Built Gas Vents

a. Factory built gas vent piping and fittings shall be laboratory tested, listed by Underwriters Laboratories, and shall comply with NFPA 211. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

b. Gas vent systems for category I vented equipment shall be Selkirk Metalbestos or Metal-Fab, "Type B" gas vents. The vents shall be of double wall construction, with at least a 0.25 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch aluminum and the outer jacket of at least 0.018 inch galvanized steel.

c. Gas vent systems for category II, III, and IV unit heaters with vents 5 inch and smaller shall be Selkirk Metalbestos "Model DCV" or Heat-fab special gas vent. The vent pipe and fittings shall be of double wall construction with a nominal 0.5 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.016 inch AL29-4C stainless steel and the outer jacket shall be constructed of at least 0.016 inch Type 304 stainless steel.

d. Chimney and vent systems for category II, III, and IV equipment with vents 6 inch and larger shall be Selkirk Metalbestos "Type PS" gas vent or Metal-Fab "Model PIC." The vent pipe and fittings shall be of double wall construction with a nominal 1 inch air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch AISI Type 316 stainless steel and the outer jacket shall be constructed of at least 0.024 inch aluminum coated steel for interior locations and AISI Type 316 stainless steel for the portions of the stack exposed to the outdoor environment.

3. Metal Gas Connectors

a. Metal gas vents shall be used indoors where the gas vent is not directly connected to the equipment and shall be constructed of at least 20 gage thickness galvanized steel. The connector shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The gas vent system shall include all necessary fittings, hangers, supports, and flashings.

B. Makeup Air Units

1. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be 100 percent outside air, constant volume type, and shall be completely assembled, wired, and tested at the factory. Indirect fired units shall be as manufactured by Hastings HVAC, Inc. "R Series," Engineered Air "Series DJ" or Weather-Rite "Model ID."

2. Where indicated in the schedules on the Drawings, makeup air units including sensor and control elements shall be given a special coating resistant to the corrosive atmosphere indicated.

3. The manufacturer of the equipment provided shall have a local service center.

4. Extra Materials

Extra Materials	Quantity
Sets of matched belts per unit	1
Sets of air filters per unit	2

5. Construction

a. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, heating section, filter section, and, when located outdoors, an inlet hood. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed access panels or hinged doors with lever type handles shall be furnished to provide access to all internal components.

b. The fan, heating, and accessory sections shall be internally insulated with 1 inch thick, 1-1/2 pound per cubic foot density mat-faced cleanable fiberglass insulation

securely fastened to the panels. When available, the heating section shall be internally insulated with 1 inch thick, 1-1/2 pound per cubic foot density foil-faced fiberglass insulation. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. The insulation shall meet the requirements of NFPA.

c. Makeup air units installed outdoors shall be of weatherproof construction, with roof panels overlapping the side panels on all sides. Seams in roof panels shall be constructed of triple-break seams or roof panels pitched for drainage. All exterior joints shall be factory sealed weather tight.

d. Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air mounted on the unit inlet. The hood shall include a two-position motorized control damper which opens when the unit is energized and closes when it is de-energized unless a discharge damper is indicated in the schedules on the Drawings. Where a discharge damper is indicated, only the inlet hood shall be provided.

6. Fan Section

a. The makeup air units shall be equipped with centrifugal fans with forward-curved or backward inclined blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with wheel diameters greater than 18 inches and permanently lubricated or grease lubricated for units with wheel diameters 18 inches and smaller.

b. Static pressure values indicated in the schedules are external to the complete unit. The heating section, filter, and housing losses are not included. An allowance of 0.35 inch water column shall be used for filter losses.

7. Motor and Drive

a. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer’s standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the Drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

b. Fan drive motors shall be as specified in the electrical paragraph.

c. Makeup air units with smaller than 10 horsepower motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

8. Heating Section

   a. The complete fuel burning assembly of gas fired units shall conform to the requirements of UL/ETL, The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.
   b. Each unit shall be designed for use with natural gasat a pressure range of 10-14 inches w.c. .
      1) Indirect Fired
         a) Burners shall be modulating power type suitable for use with the fuel gas type as required. The burners shall be capable of modulating turndown of at least 8 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff. The heat exchanger shall be of 3 or 4 pass design consisting of 400 series stainless steel primary drum heat exchanger with multitube secondary heat exchanger.

9. Filter Section

   a. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute at design conditions unless otherwise indicated in the schedules on the Drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch pleated type and shall conform to the Air Filters paragraph.

10. Controls

   a. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, and a factory installed integral disconnect switch. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect switch for field installation on the unit shall be provided. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the Drawings.
   b. A factory installed electronic discharge air temperature sensor and controller shall be provided.Where a discharge thermostat is indicated, the discharge air sensor shall be replaced with a thermostat compatible with the signal requirements of the heating section.The controls shall include controls to lock out the heating section when the outside air temperature is above the outdoor air inlet sensor setpoint.
   c. An equipment control panel, denoted by the symbol “ECP” and an identifying number, shall be furnished with the makeup air unit and located where indicated on the Drawings.

11. Accessories

   a. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage thickness zinc-

coated steel with a nominal 2 by 4 inch wood nailer strip and with supply air opening were indicated on the Drawings. The curb shall be a minimum of 24 inches high. The curb shall be approved by the National Roofing Contractors Association.

C. Positive Pressurization Units (PPU)

1. General

a. Positive Pressurization units, denoted by the symbol “PPU” and an identifying number, shall be furnished and installed where indicated on the Drawings. The positive pressurization unit shall be a complete package, designed for the removal of both organic and inorganic contaminants from outside and re-circulated air in gas or vapor atmospheres.
b. The modular chemical scrubber – pressurization / recirculation unit shall be positive pressurization unit as manufactured by Purafil, Inc., or equal. The PPU shall be as scheduled.

2. Housing Construction

a. The housing shall be constructed of 14-gauge stainless steel, seam welded. The unit shall be provided with gasketed front access door(s) for servicing all components. Latches shall have a positive locking action. All hinges and draw latches shall be constructed of stainless steel. The scrubber shall be designed for indoor installation.
b. The housing shall be provided with base support.
c. The housing shall be designed to facilitate standard fan and motor maintenance.
d. Door seats shall be self-adhesive and designed for replacement.
e. The unit shall be arranged for horizontal or vertical airflow as indicated on the Drawings and shall deliver the designed combined airflow (pressurization plus recirculation) as indicated on the Drawings. There shall be a manually controlled damper located at the intake for optimization of pressurization air. Inlet, return, and discharge openings shall be in accordance with the Drawings. The return and discharge openings shall include grilles with four-way deflection louvers.

3. Blower

a. The blower shall be located in the housing. It shall have a backward curved, centrifugal, glass reinforced polyamine wheel and be direct driven by a motor and a variable frequency drive. Blower motor shall be 460 volts 3 Phase 60 Hz. The blower system shall provide external static pressure to overcome internal losses from filters and media.
b. Blowers shall be sized to match airflow in equipment schedules on Drawings.

4. Chemical Media Sections

a. The housing shall contain two chemical media sections, designed to accommodate12.0" modular media containment devices, utilizing filter tracks.

b. Modular media containment devices shall be separated into two pieces for ease of installation. The module shall be completely recyclable and/or disposable and shall be constructed of 0.125" thick, black, high impact polystyrene.
c. Modules shall be factory-filled with selected chemical media.
d. Pressure drop through each chemical media section shall not exceed 1.30" wg. Maximum airflow through the chemical media section shall be 250 feet per minute.
e. The residence time through the chemical media section shall not be less than 0.24 seconds total - 0.12 seconds per media bed in direction of airflow. Residence time calculations shall only include media in direct path of air.
f. Module shall be UL rated Class II. Manufacturers shall provide documentation.

5. Particulate Filters

a. Pre-filters shall be 20% - 25% efficient, disposable filters. Efficiency shall be rated and tested to ASHRAE 52-76. The clean filter resistance shall not exceed 0.20" wg based on a face velocity of 100 feet per minute. One (1) total filter Purafil TP-25.
b. Final filters shall be 85% - 90% efficient pleated disposable filters. Efficiency shall be rated and tested to ASHRAE 52-76. The clean filter resistance shall not exceed 0.30" wg based on a face velocity of 100 feet per minute. One (1) total final Filter shall be Purafil JFL-90.

6. Chemical Media

a. The Purafil SP Blend Media shall consist of an equal mix (by volume) of Purafil SP Media and Purakol Media, or equal. Purafil SP Media shall be manufactured of generally spherical, porous pellets formed from a combination of powdered activated alumina and other binders, suitably impregnated with sodium permanganate to provide optimum adsorption, absorption, and oxidation of a wide variety of gaseous contaminants. The sodium permanganate shall be applied during pellet formation, such as the impregnate is uniformly distributed throughout the pellet volume and is totally available for reaction. Purakol Media shall be a premium grade activated carbon with a high surface area available for adsorption. Purafil SP Blend Media shall have the following physical properties.
    1) Purafil SP Media
        a) Moisture content: 35% maximum
        b) Average crush strength: 35% minimum – 70% maximum
        c) Average abrasion: 4.5% maximum
        d) Bulk density: 50 lbs/ft3 (0.8 g/cc) +5%
    2) Purakol Media
        a) Moisture content: 5.0% maximum
        b) CTC: 55 minimum
        c) Base material: activated carbon
        d) Bulk density: 30-32 lbs/ft3 (0.48-0.51 g/cc) +5%
    3) Purafil SP Blend Media shall be UL classified Class 1.

7. Manufacturer

a. The manufacturer shall be able to provide in-house lab analysis of the equipment media predicting the remaining life cycle of the media. Such service shall be provided at the manufacturer's expense.
b. The manufacturer shall provide vessels to meet the minimum values specified for dimension, design and intent of this specification. The vessel, blower and media shall function as a system and shall be the end product of the manufacturer to achieve standardization in appearance, operation, maintenance, spare parts and manufacturer's services.
c. The manufacturer shall have a minimum of ten (10) years experience in the design, fabrication and testing of systems that are 99.5+% efficient at removing gaseous contaminants.
d. The manufacturer shall be a single source provider of equipment, media and testing services and be certified to ISO 9001:2000 standards.
e. The manufacturer shall be Purafil, or equal.
f.

D. Heaters

1. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2. The manufacturer of the equipment provided shall have a local service center.

3. Electric Unit Heaters

a. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.
1) Electric Unit Heaters (heavy-duty). Electric unit heaters located in unclassified areas shall be Indeeco "UCI", Chromalox "LUH," or Brasch. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the Drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the Drawings to be wall hung, a wall mounting bracket shall be provided.
2) Electric Unit Heaters (corrosion resistant)
a) Where indicated on the Drawings to be corrosion resistant, unit heaters shall be manufactured by Indeeco "Triad", Chromalox "HD3D," Ruffneck "CR1 Triton," or Indeeco "Triad." Each heater shall include fan and motor assembly, operating and safety controls, disconnect switch, and shall be suitable for use with a single point power supply indicated in the schedules on the Drawings.
b) Heater elements shall be Type 304 or 316 stainless steel, fin tubular type, with stainless steel fittings forming a watertight seal between the elements and the junction box. Unit heater fan motors shall be totally

enclosed, permanently lubricated ball bearing type designed to resist corrosion and moisture. The fan blades shall be epoxy coated aluminum and the heater housing shall be at least a 20 gage Type 304 stainless steel. Where indicated on the Drawings to be wall hung, a swivel wall mounting bracket shall be provided.

c) The controls shall include automatic reset thermal cutout, fan delay relay, built-in control and motor contactors, control transformer, and terminal block all housed in a NEMA 4X enclosure. A pilot light visible on the heater exterior shall indicate heater operation.

E. Fans

1. Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the Drawings, and shall be UL listed. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.

2. The manufacturer of the equipment provided shall have a local service center.

3. Each fan shall be complete with an electric motor, factory mounted safety disconnect switch with wiring to the motor, drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower motors and fixed sheaves for 10 horsepower and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

4. Fan drive motors shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the Drawings.

5. A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

6. Where indicated in the schedules on the Drawings, fans shall be given a special coating resistant to the corrosive atmosphere indicated.

7. Extra Materials

Extra Materials	Quantity
Sets of matched belts per fan	1

8. Duct Fans

a. Duct fans, denoted by the symbol “DF” and an identifying number, shall be Loren Cook “ SQI-B”, Greenheck “SQ/BSQ,” PennBarry, or Loren Cook. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the Drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.
b. The fan housing shall be square, constructed of steel or aluminum as scheduled on the Drawings, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch fiberglass duct liner.
c. Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment’s maximum cataloged operating conditions.
d. Flexible wiring leads shall be provided from the fan motor to the safety disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

9. Wall Fans

a. Wall fans, denoted by the symbol “WF” and an identifying number, shall be Loren Cook “ACW.”, Greenheck “Model CW/CWB,” PennBarry “Fumex,” for aluminum construction fans & Loren cook “FCRU” for FRP contructions fans
b. Wall fans shall be suitable for sidewall installation; shall be direct or belt driven, centrifugal type, with aluminum or FRP wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the Drawings. Each fan shall be complete with 1/2 inch mesh aluminum bird screen or 304 stainless steel bird screen for FRP fans over all openings, and, where indicated in the schedules on the Drawings, a backdraft damper.
c. Motors and drives shall be mounted outside the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment’s maximum cataloged operating conditions.
d. A safety disconnect switch shall be mounted in the hood. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect for field installation shall be provided.

F. Dampers

1. Control Dampers

a. Control dampers shall be denoted by the symbol “CD” and an identifying number. Dampers with an area larger than 25 square feet or with any blade dimension exceeding 48 inches shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts

will be rejected and shall be replaced with an acceptable unit. The leakage rate shall not exceed 4 cubic feet per minute per ft^2 when tested at 1 in wc for all sizes 24 inches wide and above.

b. Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

c. Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

d. Control dampers shall be given a special coating identical to the coating applied to the connected ductwork and equipment.

1) Duct Mounted Control Dampers. Control dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-50." The damper frames shall be constructed of 5 inch Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch wide airfoil-shaped extruded aluminum.

2) FRP control dampers mounted in rectangular ductwork shall be Ruskin Swartwout "1108AF", Hartzell, or equal. Damper frames shall be 8 inch wide flame retardant vinyl ester. Linkage shall be 316 stainless steel. Axles and control shaft shall be fiberglass. Damper blades shall be 6 inch minimum wide vinyl ester. Bearings shall be Teflon or FRP. The damper shall meet the flame spread rating requirements of not over 25 and smoke developed index of not over 50 of a Class 1 duct per UL 181.

3) Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-40." Control damper frames shall be constructed of 4 by 1 inch 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch wide airfoil-shaped extruded aluminum.

2. Volume Control Dampers

a. Volume control dampers shall be denoted by the symbol "VCD."

b. Aluminum volume control dampers in round ductwork shall be Arrow United Industries "Type 75," or Ruskin "Model CDRS25." Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type OBDPL-507," or Ruskin "Model CD51." Round dampers shall be fabricated of aluminum, with a nominal 7 inch long, 0.080 inch thick frame, and a minimum 0.080 inch thick circular blade. Rectangular volume control dampers shall be fabricated with a 1 by 4 or 5 inch by 0.081 inch thick extruded aluminum frame and opposed operating blades. Blades shall be of .125 inch thick aluminum with aluminum shafts and ball bearings.

c. FRP volume control dampers in round ductwork shall be of the single blade type complete with channel type frame, close fitting blade, full length axle, and bearings. Each damper shall have the same inside dimensions as the connecting ductwork. Axles shall be continuous through the damper. Dampers shall be furnished with a blade stop and shaft seal. The damper shall meet the flame spread rating requirements of not over 25 and smoke developed index of not over 50 of a

Class 1 duct per UL 181. Dampers shall be Ruskin Swartwout "912", Belco, or equal.

1) Frame: Flame retardant, Vinyl Ester
2) Blade: Vinyl Ester
3) Axle: Vinyl Ester or Type 316 Stainless Steel
4) Blade Seal: EPDM
5) Shaft Seal: Viton
6) Flanges: Flanges shall comply with ASTM D3982

d. The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

G. Damper Operators

1. The damper operators shall be direct coupled. Each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

2. Each operator shall have sufficient torque to operate the connected control damper based on at least 130 percent of control damper area. Each damper operator shall have at least a 50 inch-pound normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators or operators with a greater running torque shall be furnished to produce the torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the Drawings. **[**Face dampers shall fail to the closed position and bypass dampers to the open position.**]**

3. Two-position direct coupled electric damper operators shall be Belimo "NFBUP-S" or "AFBUP-S," Honeywell "MS4100 Series," or Johnson Controls. Foot-mounted type electric damper operators shall be Honeywell "Model M4185," or Johnson Controls "Model M100."

4. Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac or the power supply available from the temperature control system furnished. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA enclosure with a rating equal to or better than the damper operator.

a. Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable for round shafts. The operators shall be suitable for direct mounting to shafts up to 1 inch and shall be complete with mounting brackets and damper position indicator.

H. Air Outlet and Inlet Devices

1. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, or Titus. Air outlet and inlet devices shall be furnished and installed where indicated on the Drawings.

2. Where air outlet and inlet devices are installed in ductwork given a special coating, an identical coating shall be applied to the air outlet and inlet devices.

3. Ceiling Diffusers

   a. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the Drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the Drawings. Size, location, and direction of airflow shall be as indicated on the Drawings.

4. Registers and Grilles

   a. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the Drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

I. Flexible Connections

1. Flexible connections located indoors shall be Ventfabrics “Ventglas.” Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics “Ventlon.”

2. Ductwork connections to the air handling equipment, and where indicated on the Drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

3. Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20° to 180° F and shall weigh at least 27 ounces per square yard .

4. Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10° to 250° F and shall weigh at least 24 ounces per square yard .

J. Air Filtration Equipment

1. Pleated Air Filters

   a. Pleated air filters shall be American Air Filter “AM-AIR 300X” or Farr “30/30.” Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall

be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have a minimum efficiency reporting value (MERV) based on the ASHRAE 52.2 guidelines of at least MERV 6.

b. One inch pleated air filters shall have at least 14 pleats per linear foot and at least 1.9 square feet of media per square foot of filter area. One inch filters shall have a maximum initial resistance of 0.10 inch water column at 300 feet per minute .

c. Two inch pleated air filters shall have at least 12 pleats per linear foot and at least 4.2 square feet of media per square foot of filter area. Two inch filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute .

K. Draft Gauges

1. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge."

2. Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20° to 140° F , and a range of 0 to 1.0 inch water column , with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves. When mounted across filters, the signal flag shall be set at 0.75 inch water column .**]**

L. Sheet Metal Ductwork

1. Ductwork, accessories, bracing, and supports shall be constructed of aluminum . Where more than one material is indicated, ductwork, accessories, bracing, and supports shall be constructed of galvanized steel unless otherwise indicated on the Drawings. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards unless otherwise indicated. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork.

2. Aluminum ductwork shall be constructed of aluminum alloy 3003-H14 or better in accordance with ASTM B209.

3. Plenums shall be constructed of reinforced 0.08 inch thickness aluminum sheet metal.

4. Sheet metal fan boxes shall be fabricated with 0.125 inch thickness aluminum sheet metal skin and structural framing of sufficient strength to support the fan box and the fan mounted on the box. Drawings of the fan boxes shall be submitted in accordance with the Submittals Procedures section.

5. Sealants shall be suitable for the duct service and shall maintain leakage integrity at pressures in excess of the ductwork pressure classification.

6. Where indicated on the Drawings, ductwork and accessories shall be given a special coating resistant to the corrosive atmosphere indicated. Where no special coating for ductwork is indicated, the coating shall be as specified in the Protective Coatings sections.

M. FRP Ductwork

1. FRP ductwork shall be installed where indicated in the notes on the Drawings.

2. FRP ductwork, including fittings, shall be constructed of fiberglass reinforced plastic, as manufactured by Spunstrand, Monoxivent, or equal.

3. Ductwork shall be manufactured per SMACNA, and industry standard PS 15-69 minimums. Designed for a minimum of 10" w.c. pressure and 10" w.c. vacuum. A minimum designed structural safety factor of 4 shall be used. All ductwork, fittings, and appurtenances shall be suitable for the following temperature conditions: -10°F to 120°F.

4. The ductwork shall be suitable for water treatment plant service and will supply and exhaust air from corrosive chemical areas. The ductwork shall have a minimum 20 mil liner and 100 mil corrosion barrier. Resin shall be of the premium vinyl ester type and shall not contain fillers except as required for thioxtropic control of fire retardance. The structural layer shall be as required for design service and shall be filament wound using the premium resin. The duct exterior shall have a relatively smooth surface free of exposed fibers. All resin and joint material shall be suitable for a 120ºF service. The duct shall achieve a Class 1 flame spread rating. The resins shall contain antimony trioxide for fire retardance. The flame spread rating shall be less than 25. The duct and fittings, as a finished composite shall meet the flame spread rating requirements of not over 25 and smoke developed index of not over 50 of a Class 1 duct per UL 181 and UMC 10-1, ASTM E-84, and ASTM D 3982.

5. Wall thickness shall comply with SMACNA Thermoset Duct Construction Standards. The ductwork shall be furnished with the minimum wall thicknesses as required by the SMACNA standard. Rectangular ductwork wall thickness shall be determined by substituting the long side for the round diameter.

   a. 4 through 12 inches diameter: 0.125 inches
   b. 13 through 36 inches diameter: 0.188 inches
   c. 37 inches and larger: 0.268 inches.

6. Minimum glass content shall be 50%.

7. Field joints shall be butt-type wet lay-up method. Flanged connections shall be provided where indicated on the contract drawings. Joining materials shall be of the same material as the duct, forming a continuous FRP component system. Manufacturer's installation instructions shall be followed. Shop fabricated assemblies should be provided to the maximum extent possible, to minimize the number of field joints. Shop fabrications including fittings and specials must be constructed by the ductwork manufacturer or ductwork manufacturer’s certified pipe fabrication source.

8. Flanged joints shall be provided at each damper and item of equipment to facilitate disassembly, at each change in material, and where indicated on the Drawings. Flanged joints shall be “hand lay-up” per ASTM D 3982-21. 316 stainless steel bolts, nuts, washers, and neoprene gaskets shall be provided for all flanged connections in the system, including connections to equipment.

9. Expansion joints shall be furnished at the locations indicated on the Drawings and at other locations required for proper pipe installation. Expansion joints shall be resistant to ultraviolet light and shall be suitable for the service conditions.

10. Expansion joints shall be fully molded type rated for a minimum 3 psi working pressure and shall consist of an inner tube, body, and outer cover to be compatible with the specified service conditions. The tube shall be a minimum of 1/4 inch thick EPDM with two ply of high tensile nylon, polyester, or kevlar fabric reinforcement. The cover shall be a minimum 1/16-inch elastomer and shall be resistant to ultraviolet light.

    a. Circular construction only.
    b. Backing Rings: 3/8 IN thick, 2 IN wide, type 316 stainless steel.
    c. Extension: 1 IN
    d. Compression: 3.8 IN.
    e. Lateral Offset: 2.5”
    f. Thickness: ¼ IN, minimum.
    g. Durometer value: 40 or less

11. Slip on type expansion joints shall fit tightly on the outside diameter of the piping and shall be secured in place by stainless steel adjustable bands with worm screw type adjustments to provide a gastight connection.

12. Flanged type expansion joints shall have split stainless steel retaining rings and shall have ASTM D3982 diameter and drilling. Expansion joints shall be Red Valve "Duct Expansion Joints", Mercer Rubber Company, or Holz Rubber Company.

13. Turning vanes and splitters shall be fiberglass matching the construction of the ductwork, and shall be provided where indicated on the drawings. All bolts for flange connections shall be 316 stainless steel.

14. Supports and hangers shall be designed, fabricated, and installed in accordance with the requirements of SMACNA’s FRP Duct Construction Manual.

15. Ductwork shall be protected as required for protection of the material and coatings during shipping, handling and storage. Ductwork shall be shipped, delivered, and handled in accordance with the Manufacturer’s instructions where they differ from the Product Delivery Requirements and the Product Storage and Handling Requirements sections.

16. Minimum physical properties:

    a. Barcol hardness: 40 to 55.
    b. Tensile strength: 6,000 to 10,000 psi.
    c. Flexural strength: 10,600 to 14,600 psi.

d. Flexural modulus: 700,000 to 1,000,000 psi.
e. Temperature limits: 120 degrees F continuous.

N. Duct Insulation

1. Interior duct liner shall be Knauf "Sonic XP Duct Liner," CertainTeed "ToughGard R," or Johns Manville "Linacoustic RC."

2. Interior duct liner shall be 1-1/2 pound per cubic foot density, spray coated duct liner with an "R" value of at least 4.2 ft2 hr F/BTU per inch thickness at 75° F . The insulation shall be suitable for temperatures up to 250° F and shall have at least a 0.55 NRC per 1 inch thickness. The insulation shall conform to ASTM C1071. The insulation surface shall be resistant to microbial growth in accordance with UL 181, ASTM C1338, or comparable test method and shall be cleanable in accordance with NAIMA recommended practices.

O. Access Doors

1. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Insulated doors shall be insulated with the same thickness insulation as the duct in which it is installed. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

P. Temperature Controls

1. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2. The manufacturer of the equipment provided shall have a local service center.

3. Performance and Design Requirements

a. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the Drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.
b. Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control switches, motor starters, and the HVAC equipment, shall be

furnished and installed as specified in the Electrical Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section.

4. Tolerances

a. Unless otherwise indicated, the controls shall maintain space temperatures within ±2° F , and the relative humidity within ±5 percent of the setpoint.

5. Thermostats

a. Where indicated on the Drawings, thermostats shall be constructed of materials resistant to or shall be protected from the corrosive atmosphere indicated. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.

1) Two Position Wall Mounted Thermostats

a) Two position wall mounted thermostats shall be Honeywell “T631A Airswitch,” Penn Controls “A19BAC-1,” or Siemens Building Technologies.

b) Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35° F to 100° F with a nonadjustable differential of 3.5° F . The thermostats shall have a spdt switch rated for 1 horsepower .

2) Two position corrosion resistant wall mounted Thermostats

a) Two Position Corrosion Resistant Wall Mounted Thermostats. [used.][position wall mounted thermostats located in wet or corrosive environments shall be Honeywell "T631F"

b) Two position corrosion resistant wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F [2°C to 38°C] with a nonadjustable differential of 3.5°F [2°C]. The thermostats shall have a spdt switch rated for 1 horsepower [0.746 kW].**]**

3) Low Limit Thermostats

a) Low limit thermostats shall be Honeywell “L480,” Penn Controls “Model A11B-1,” or Siemens Building Technologies.

b) Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35° F to 45° F , and shall be automatically reset.

4) Modulating Duct Mounted Thermostats

a) Modulating, duct mounted thermostats shall be Honeywell “Model T991,” Penn Controls “Model A80ABA-2,” or Siemens Building Technologies.

b) Modulating, duct mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a range of approximately 10° F to 90° F with an adjustable throttling

range of approximately 5° F to 24° F , and shall be furnished with a duct mounting kit.

5) Programmable Wall Mounted Thermostats
   a) Programmable, wall mounted thermostats shall be Honeywell "Model T7300," Penn Controls, or Siemens Building Technologies.
   b) Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45° F to 95° F with the following features:
      - 7 day programming with 2 occupied/unoccupied periods per day.
      - Automatic heat/cool changeover.
      - Battery backup.
      - Setback controls to automatically restart and temporarily operate system during setback periods.
      - Digital display.
      - Temporary override of setpoints.
      - 2 configurable LED's.

6. Temperature Control Panels

   a. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be manufactured by Hoffman Engineering, Hubbell Wiegman, or Rittal Corporation. Temperature control panel enclosures shall be NEMA Type 12 unless otherwise indicated on the electrical Drawings with a special area designation. Where a panel is located in a room with a special area designation, the panel shall be constructed to meet the special area designation requirements. Panels shall be designed for wall mounting and shall be completely prewired and checked. All electrical accessory devices and internal wiring shall be furnished and installed.
   b. Where required by the applicable codes and ordinances, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing agency acceptable to the governing authority.
   c. All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel. Accessories such as indicating lights, pushbuttons, alarm horns, and selector switches shall be mounted on the front hinged covers of the panels. The accessories and panels shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panel with corrosion-resistant pan head screws.
   d. Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, and smoke detectors. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operation on the Drawings.

e. All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Wiring for secondary power distribution and for control, annunciator, and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the legend on the panel wiring diagrams.

f. Equipment operational control and run/off status shall be provided from terminal blocks within the respective motor starter. Refer to the electrical Drawings for additional information.

1) Selector Switches

a) Selector switches shall be Micro Switch "Type PT," Cutler-Hammer "10250T Series ," or General Electric "CR." Selector switches shall be heavy-duty 30 mm oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the Drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

2) Push Buttons

a) Push buttons shall be Micro Switch "Type PT," Cutler-Hammer "10250T Series," or General Electric "CR." Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

3) Indicating Lights

a) Indicating lights shall be Micro Switch "Type PT," Cutler-Hammer "10250T Series ," or General Electric "CR." Alarm, indicator, and running status lights shall be furnished with lamps. Indicating lights shall be heavy-duty, 30 mm, push-to-test, oiltight type with LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the device.

4) Alarm Horns

a) Alarm horns shall be Federal Signal "Model 350." Alarm horns shall have a sound output of 100 dB at 10 feet [3 m]. Horns shall be furnished with mounting hardware suitable for flush mounting.

5) Relays

a) Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series A3, A4." Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials

or engraved switch settings marked in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

6) Terminal Blocks and Panel Wiring
   a) Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.
   b) A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.
   c) All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of the depth of the duct available for future use after the installation including all field wiring, has been completed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.
   d) Where signal wiring must be routed to more than one panel or device, the requested circuit routing shall be as indicated on the electrical one-line diagrams.
7) Control Power Transformers
   a) Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.
8) Painting
   a) Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils . One quart of paint shall be furnished with the panels for future touchup painting.

7. Pressure Differential Airflow Switches

   a. Pressure differential airflow switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the Drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Switches used for proving airflow shall be selected with the lowest operating range such that the switch activates at 50 percent of the system airflow. Differential switches shall be UL listed.
   b. Where indicated on the Drawings, pressure differential switches shall be provided with an explosion-proof housing suitable for a NEC Class 1, Division 2, Group D environment. Where differential pressure switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided. Where indicated in the drawings a corrosion resistant pressure differential switch shall be provided.
   c. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800." Explosion-proof pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1950G." Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spdt, shall be rated 10 amperes at 120 volts ac and for a temperature range of 0° F to 125° F , and shall be provided with corrosion resistant mounting brackets. Unless otherwise indicated on the Drawings, initial setpoints of pressure differential switches located across filters shall be 0.75 inch water column to alarm high filter pressure loss and 0.1 inch water column when mounted in air systems to alarm ventilation failure.

8. Accessory Components

   a. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

9. Electrical Wiring

   a. Detailed wiring diagrams shall be submitted in accordance with the Submittals Procedures section. The wiring diagrams shall show the internal connections of the control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.
   b. Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

c. Conduit for all HVAC control circuits in indoor locations shall be furnished and installed under this section. Conduit type shall be as specified in the Electrical Section.

2.5 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.6 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.7 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.8 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2.9 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

B. Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3.2 PREPARATION

A. Field Measurement

1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

B. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings sections.

3.3 INSTALLATION

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Gas fired equipment furnished with pressure regulators that require a vent shall have an independent vent routed to outside. The vent shall be designed to prevent the entry of water or foreign objects.

C. The space beneath baseplates shall be grouted as specified in the Grouting section.

D. Gas Vents

1. Gas vents for all equipment exhausting combustible material shall be installed where indicated on the Drawings. Gas vent systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

2. Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

3. Gas vents shall be supported where indicated on the Drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the gas vent systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

4. The gas vent heights indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

5. All vertical gas vents shall be equipped with a capped tee to serve as a condensate drain. Vents 6 inches and larger shall be equipped with a condensate drain connection.

6. Where metal vents are used, each joint shall be sealed with sealant and/or aluminum or Teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal vents are used to vent equipment, a double wall vent shall be used outside and shall extend through the wall a minimum of 6 inches . The annular space of the double wall vent shall be sealed at the connection point between the double and single wall pipes. Single wall vents routed through unconditioned spaces or in locations below 8 feet above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150° F .

7. Gas unit heater vent shall be installed with a minimum of 12 inches of straight pipe attached to the venter outlet before the installation of an elbow.

E. Makeup Air Units

1. Flexible connections shall not be in tension when the fans are operating. Curb mounted units shall be firmly anchored to the equipment curbs with corrosion resistant fasteners.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

F. Positive Pressurization Units

1. Where indicated on the Drawings, flexible connections shall be installed between inlet and sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where unit inlet and outlets are exposed, manufacturer’s standard grilles shall be installed over the opening.

G. Heaters

1. The bottom elevation of unit heaters shall be 8 feet above finished floor unless otherwise indicated.

H. Fans

1. Where indicated on the Drawings, flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

I. Damper Operators

1. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

2. The damper operator shall be installed to prevent entry of moisture from contacting internal parts. Conduit shall enter the operator from below or horizontally and incorporate a drip leg to prevent water from following the conduit into the operator interior.

3. The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position.

J. Air Outlet and Inlet Devices

1. Air outlet and inlet devices shall be installed level and plumb and in accordance with the manufacturer's written instructions.

K. Draft Gauges

1. Draft gauges for filters located more than 8 feet above the finished floor shall be mounted on the nearest wall, 5.5 feet above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

L. Sheet Metal Ductwork

1. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards unless otherwise indicated. The locations, arrangement, and sizes of ductwork shall be as indicated on the Drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

2. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch .

3. Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards in accordance with the following:

	Duct Type			
	Supply		Exhaust	Return
Duct Location	≤ 2 inches wc	> 2 inches wc		
Outdoors	A	A	A	A
Unconditioned Areas	B	A	B	B
Conditioned Spaces				
(concealed ductwork)	C	B	B	C
(exposed ductwork)	A	A	B	B

Sealing Levels

A - All transverse joints, longitudinal seams, and duct wall penetrations

B - All transverse joints and longitudinal seams

C - Transverse joints only

4. All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

5. Ductwork shall be supported as required by SMACNA. Where ductwork is connected to equipment, it shall be independently supported with no weight bearing on the equipment and in such a manner that the equipment maybe removed for service without temporary support of the ductwork. Ductwork shall be supported within 24 inches of each elbow and within 48 inches of each branch intersection. Strap or wire hangers shall not be used where the hanger length exceeds 5 feet .

6. Ductwork shall be constructed and installed in accordance with the Drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height

of 8 feet above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch lighting allowance between the ceiling and the bottom of the ductwork.

7. In vertical ducts with a closed bottom which terminate less than 24 inches above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch drain hole in the bottom of the duct.

8. Turning vanes shall be installed in all elbows with 45 degree or greater angles. Vanes shall be double thickness or a minimum 4.5 inch radius type for vanes 30 inches and longer, where installed in ducts with velocity greater than 2000 fpm , or where installed in ducts with a pressure classification greater than 2 inches wc . Where 4.5 inch or double thickness type turning vanes are required, each vane shall be welded to the vane runner.

M. FRP Ductwork

1. FRP ductwork joints shall be carefully and neatly made in accordance with the following specified requirements. All field joints made by trained and certified employees that are not representatives of the pipe manufacturer shall be made using individually packaged joint kits.

2. Flange bolts shall be tightened sufficiently in a crisscross pattern to slightly compress the gasket and make a good seal, but not so tight as to distort the flanges. A flat washer shall be installed under each nut and bolt head.

3. Laminated butt joints shall be made in accordance with the manufacturer's recommendations. Finished joints shall be built up in successive layers, shall be as thick as the pieces being joined, and shall be as crevice-free as is commercially practicable. The width of the first layer shall be at least 4 inches. Successive layers shall be increased uniformly to provide the specified minimum total width of overlay which shall be centered on the joint. Crevices between jointed pieces shall be filled with resin, leaving a smooth inner surface. The interior of joints shall also be sealed by covering with not less than 0.05 inch of liner of the same material as the ductwork. Inside welds should be done on duct 24 inches and larger where accessible.

4. The inner surface shall be free of cracks and crazing, with a smooth finish, and with an average of not more than two pits per square foot, provided the pits are less than 1/8 inch in diameter, not more than 1/32 inch deep, and covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Such surfaces may be reinforced with glass surfacing mat, synthetic fibers, or other suitable material.

5. FRP duct shall be supported per the latest requirements as indicated in the SMACNA Thermoset FRP Duct Construction Manual.

N. Duct Insulation

1. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

2. Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

3. The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

4. The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

5. The following ducts shall be insulated with interior duct liner unless indicated on the Drawings to be wrapped or otherwise indicated:

Location	Ductwork	Insulation Thickness
Exterior	a. All ductwork	2 inches
Interior within conditioned space (heated or cooled)	a. Heating supply and return	1 inch
	b. Cooling supply and return	1 inch
	c. Heating and cooling supply and return	1 inch
	d. Makeup air outside area served	1 inch
	e. Outside air (including plenums)	1.5 inches
Interior within unconditioned space	a. Heating supply and return	1.5 inches
	b. Cooling supply and return	1.5 inches
	c. Heating and cooling supply and return	1.5 inches
	d. Makeup air outside area served	1.5 inches
	e. Outside air (including plenums)	2 inches]
Note: Exhaust systems shall not be internally lined.		

O. Flexible Duct and Takeoffs

1. The length of the flexible ductwork shall not exceed 8 feet . All support saddles for flexible duct shall be a minimum of 6 inches wide.

P. Access Doors

1. Airtight access doors shall be provided for inspection of all dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the Drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches square for hand access, 18 inches for shoulder access, or as indicated on the Drawings. Each access door shall be installed to open against the pressure in the duct.

Q. Temperature Controls

1. Automatic temperature controls shall be furnished and installed as indicated on the Drawings and as specified herein.

2. Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

3. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

4. Temperature Control Panels

a. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet above the finished floor.

5. Thermostats

a. Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.
b. Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. An installation check by an authorized representative of the manufacturer is not required for equipment specified in this section.

2. Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section,

and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

3. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

4. All costs for these services shall be included in the Contract Price.

B. Startup and Testing

1. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 CLEANING

A. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the cleaning, testing, adjusting, and balancing of the air associated with the heating, ventilating, and air conditioning (HVAC)

1.2 GENERAL

A. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

2. Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

C. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air and systems.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals

Procedures section. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

2. The apparatus report sheets shall include the following information:

   a. Title Page:
      1) Company name
      2) Company address
      3) Company telephone number
      4) Project name
      5) Project location
      6) Project Engineer
      7) Project Contractor
      8) Project altitude
      9) Date

   b. Instrument List:
      1) Instrument
      2) Manufacturer
      3) Model
      4) Serial number
      5) Range
      6) Calibration date

   c. Air Moving Equipment:
      1) Unit number
      2) Location
      3) Manufacturer
      4) Model and serial number
      5) Airflow, design and actual
      6) Total static pressure (total external), design and actual
      7) Static pressure, inlet and discharge
      8) Total pressure
      9) Fan RPM, design and actual

   d. Electric Motors:
      1) Manufacturer
      2) Motor type and frame
      3) HP/BHP
      4) Phase, voltage, amperage, nameplate, actual, no load
      5) RPM
      6) Service factor
      7) Starter size, rating, heater elements

   e. V-Belt Drive:
      1) Required driven RPM
      2) Driven sheave make, diameter, and RPM

3) Belt make, size, and quantity
4) Motor sheave make, diameter, and RPM
5) Center to center distance, maximum, minimum, and actual

f. Return Air/Outside Air Data:
1) Unit number
2) System airflow, design and actual
3) Return airflow, design and actual
4) Outside airflow, design and actual
5) Return air temperature
6) Outside air temperature
7) Mixed air temperature, design and actual
8) Outside/return air ratio, design and actual

g. Coil Data:
1) Unit number
2) Location
3) Service
4) Manufacturer
5) Fin spacing and rows
6) Face area
7) Airflow, design and actual
8) Air velocity, design and actual
9) Entering air DB temperature, design and actual
10) Entering air WB temperature, design and actual
11) Leaving air DB temperature, design and actual
12) Leaving air WB temperature, design and actual
13) Air pressure drop, design and actual

h. Duct Traverse:
1) System zone/branch
2) Duct size
3) Area
4) Velocity, design and actual
5) Airflow, design and actual
6) Duct static pressure
7) Air temperature
8) Air correction factor

i. Outlet and Inlet Devices:
1) Air outlet and inlet device number
2) Room number/location
3) Air outlet and inlet device type
4) Air outlet and inlet device size
5) Area factor
6) Velocity, design, preliminary, and final
7) Air flow, design, preliminary, and final
8) Percent of design airflow

j. Sound Level Report:
   1) Location
   2) Octave bands - equipment off
   3) Octave bands - equipment on

k. Air Cooled Condenser:
   1) Unit number
   2) Location
   3) Manufacturer and model
   4) Refrigerant type and capacity
   5) Entering DB air temperature, design and actual
   6) Leaving DB air temperature, design and actual
   7) Number of compressors
   8) Suction pressure and temperature
   9) Condensing pressure and temperature

l. Ducted split :
   1) Unit number
   2) Location
   3) Manufacturer and model
   4) Refrigerant type and capacity
   5) Entering DB air temperature, design and actual
   6) Leaving DB air temperature, design and actual
   7) Number of compressors
   8) Suction pressure and temperature
   9) Condensing pressure and temperature

3. Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Submittals Procedures section.

1.4 QUALITY ASSURANCE

A. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

1.5 MAINTENANCE

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2.2 CONSTRUCTION

A. Painting

1. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatingssections.

PART 3 - EXECUTION

3.1 INSPECTION

A. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

B. A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
1 inch pleated	0.15 inch water column
2 inch pleated	0.35 inch water column

3.2 STARTUP REQUIREMENTS

A. System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

3.3 FIELD PERFORMANCE TESTING

A. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner

acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

B. Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
1 inch pleated	0.75 inch water column
2 inch pleated	1 inch water column

C. Refrigerant Piping

1. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

2. After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

3. The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent over that period.

3.4 CLEANING

A. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

B. Chemical Pipe Cleaning

1. Piping shall be cleaned with a liquid alkaline compound consisting of emulsifying agents and detergents conforming to applicable codes governing the addition of nonpotable chemicals to the buildings' mechanical systems and their discharge to public sewerage systems. All terminal control valves shall be placed in the open position during cleaning.

2. After piping systems have been cleaned, they shall be flushed with a neutralizing agent recommended by the cleaner manufacturer. All strainer screens in the piping systems shall be removed, cleaned, and replaced.

3. After the completion of the flushing and neutralizing, the piping systems shall be inspected and any remaining sludge shall be removed. This inspection shall include disassembly of components if necessary.

3.5 ADJUSTING & BALANCING

A. The air system shall be adjusted and balanced.

B. All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

C. All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

D. Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

E. All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

F. Air Systems

1. Air systems shall be adjusted to the design airflows indicated on the Drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the Drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement or noise. Fans shall not be adjusted above the maximum safe speed as determined by the fan manufacturer.

2. Dampers with operators shall be checked for tight shutoff when in the closed position. Shutoff dampers shall not be used for balancing.

End of Section

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SECTION 23 70 00 CENTRAL HVAC EQUIPMENT REFRIGERATION SYSTEMS

SECTION 23 80 00 DECENTRALIZED HVAC EQUIPMENT

SECTION 15650 REFRIGERATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

1. This section covers the furnishing and installation of refrigerant piping and accessories, ductless split systems and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

2. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

1. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

2. Coordination

   a. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
   b. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
   c. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
   d. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

3. General Equipment Stipulations

a. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

C. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL safety requirements.

3. The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the Drawings.

D. Power Supply

1. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

E. Metal Thickness

1. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.

F. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings

shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Ductless Split System Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Location and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1.4 QUALITY ASSURANCE

A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

B. For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

C. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

D. Elevation

1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2.3 ACCEPTABLE MANUFACTURERS

1. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

A. Refrigerant Piping and Accessories

1. Refrigerant piping shall conform to the Copper Tubing and Accessories section. Piping shall be supported as specified in the Pipe Supports section. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

2.5 EQUIPMENT

A. Ductless Split Systems

1. Ductless split systems shall be furnished and installed where indicated on the Drawings. Each unit shall include an indoor ceiling suspended fan coil section and an outdoor remote condensing unit/heat pump. Each unit shall be fully charged with Refrigerant-32and compressor oil. Provide all leak detection and safety devices required for an A2L refrigerant. Each unit to be provided with all necessary appurtenances required for fully functioning and safe system as required for the A2L refrigerant to be used and to comply with all industry requirements, standards, and codes associated with A2L refrigerant to be used. A programmable thermostat shall be provided for control of each system.

2. Ductless split systems shall be as manufactured by LG, Carrier “Model 53QAB” (air conditioning) or “Model 53QAE” (heat pumps), Friedrich, or equal.

3. The manufacturer of the equipment provided shall have a local service center.

4. Fan Coil

a. Each fan coil unit , denoted by the symbol “FC” and an identifying number, shall be of the ductless, indoor, under-ceiling mounted, direct expansion type. Each fan coil unit shall consist of a fan, evaporator coil, air filter, return grille, supply louver, mounting harness, and drain pan.

b. Fans shall be centrifugal type designed for quiet operation. Evaporator coils shall be copper tube with aluminum fins and galvanized steel tube sheets. The fins shall be bonded to the tubes by mechanical expansion. Air filters shall be of the cleanable type. Each unit shall be provided with access doors for easy removal of the filters. Each fan coil shall be provided with a mounting system and supports.
c. The fan coil fan shall be suitable for the power supply indicated on the Drawings.

5. Condensing Unit/Heat Pump

a. Each condensing unit/heat pump, denoted by the symbol "CU" for air conditioning and an identifying number, shall be factory assembled suitable for outdoor installation.
b. Each condensing unit shall have a galvanized steel cabinet that shall be bonderized and coated with a baked-enamel finish. The housing shall have removable panels, weep holes, and mounting holes. Compressors shall be high-efficiency, Twin rotary, or scroll type with overload protection. Condenser coils shall consist of louvered aluminum fins mechanically bonded to copper tubing. Each unit shall be provided with resilient compressor vibration isolators to minimize noise. Each fan shall have a TEFC motor.

6. Accessories

a. Each unit shall be provided with an electric programmable thermostat capable of controlling all unit functions. The thermostat shall be automatic changeover type with integral sub-base.
b. Where indicated on the Drawings, an internal condensate pump shall be provided to remove condensate from the drain pan.
c. All copper surfaces shall be protected against corrosion by a shop applied special coating.
d. Each unit shall be provided with a low ambient control kit to allow operation when outdoor temperatures are between 0° and 60° F. External service valves and electrical knockouts shall be provided.

2.6 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.7 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.8 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.9 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2.10 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Field Measurement

1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

B. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted

surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3.3 INSTALLATION

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. The space beneath the baseplate shall be grouted as specified in the Grouting section.

C. Valves

1. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.

D. Ductless Split Systems

1. Ductless split systems shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the recommended clearances.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

B. Startup and Testing

1. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3.5 CLEANING

A. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

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SECTION 26 0511 - ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

B. This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

1.2 GENERAL

A. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

B. Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Coordination

1. Electrical work shall conform to the construction schedule and the progress of other trades.

F. Anchor Bolts and Expansion Anchors

1. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch [19 mm] will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

G. Drawings

1. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1.3 CODES AND PERMITS

A. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

B. Equipment covered by this section shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor’s expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1.4 SEISMIC DESIGN REQUIREMENT.

A. Seismic Design Requirements

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.5 IDENTIFICATION.

A. Conduit

1. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gauge stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

B. Conductors

1. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

2. Conductor Identification Number

a. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.
b. The wire markers **[**shall be of the heat-shrinkable tube type, with custom typed identification numbers**]**
c. The wire numbers shall be as indicated on the equipment manufacturer's drawings.
d. The wire markers shall be positioned to be readily visible for inspection.

3. Conductor Color Coding

a. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.
b. The following color coding system shall be used:
   1) 120/240V single-phase — black, red, and white
   2) 120/208V, three-phase — black, red, blue, and white
   3) 120/240V, three-phase — black, orange, blue, and white
   4) 277/480V, three-phase — brown, orange, yellow, and gray
   5) 2400/4160V, three-phase — black, red, blue, and white
   6) 7200/12470V, three-phase — black, red, blue, and white

c. Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.
d. Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

C. Motor Starters

1. Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the motor starters.

D. Control Stations

1. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.

E. Circuit Breakers

1. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

F. Disconnect Switches

1. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower rating. An additional nameplate, engraved or etched, laminated black-over-white plastic, with 1/8 inch letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.

G. Arc Flash Hazard Labels

1. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E. Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

2. Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1.6 SUBMITTALS

A. Drawings and Data – General

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the

Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

a. Drawings and data.
b. Operating manuals.
c. Samples.
d. Test reports
e. Studies

B. Submittal Details & Identification

1. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.
b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.
c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.
d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.
e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer’s descriptive bulletins and product sheets.

C. Engineering and Testing Firm

1. Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.

D. Cable and Conduit Submittal

1. Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

E. Cable Samples

1. In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

F. Seismic Design Requirements

1. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.7 PROTECTION AND STORAGE

A. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2.1 POWER SERVICE ENTRANCE

A. Contractor shall consult the local electric utility regarding their service installation requirements, and shall furnish the service equipment in compliance with these requirements.

B. The scope of supply for the electric utility is as follows:

1. Purchase and install electric utility transformer

2. Terminate primary and secondary conductors

3. Install meter and meter base

4. Purchase and install primary cable

C. The scope of supply for the Contractor shall be as follows:

1. Primary trenching/backfill and conduit.

2. Secondary service (cables, conduit, trenching, backfill, etc)

3. Install meter base Unistrut rack

4. Transformer base and conduit from transformer to Unistrut rack for utility meter. Transformer base shall meet the utility’s requirements.

5. A weatherhead shall be provided on each service riser conduit.

2.2 CABLE

A. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.

B. All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

C. Lighting Cable

1. Lighting cable (Figure 1-26 0511 THHN-THWN-2) shall be provided only in lighting and receptacle circuits operating at 277 volts or less. Lighting and receptacle circuits, 8 AWG [10 mm2] or larger, shall be as specified for 600 volt **[**(Figure 2-26 0511 XHHW-2)**]** power cable.

D. 600 Volt Power Cable

1. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt **[**(Figure 2-26 0511 XHHW-2) power cable.

E. Instrument Cable

1. Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be **[**(Figure 4-26 0511 single pair)**][**, (Figure 5-26 0511 single triad)**][**

F. AFD Cable

1. **[**Power cable to equipment controlled by an adjustable frequency drive operating at 600 volts or less, shall be 2000 volt (Figure 15-26 0511) multiconductor power cable.**]**

2.3 RACEWAY

A. Conduit and cable tray shall be as described in the following paragraphs:

B. Liquidtight Flexible Metal Conduit

1. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled.

C. Rigid Nonmetallic (PVC) Conduit

1. PVC conduit shall be heavy wall, Schedule**[**40 and 80**]**, UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651.

D. PVC-Coated Rigid Steel Conduit

1. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils .

2. A chemically cured two-part urethane coating, at a nominal 2 mil thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

3. Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches , whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils .

4. All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

5. PVC coated rigid steel conduit shall be manufactured by Calbond, Ocal, or Robroy Industries.

E. Rigid Aluminum Conduit (RAC)

1. Rigid aluminum conduit and fittings shall be manufactured of 6063-T1 alloy, shall conform to ANSI C80.5, and shall be manufactured in accordance with UL 6A.

2.4 WIRING DEVICES, BOXES, AND FITTINGS

A. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

B. Conduit Boxes and Fittings

1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.

2. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.

3. Sheet steel device boxes shall be manufactured by Appleton, Raco, or Steel City.

4. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries. Where used in hazardous locations, PVC coated fittings and boxes shall be UL 1203 listed.

5. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

6. Fittings for liquid-tight flexible conduit shall be listed or comply with UL 514B and meet NEMA FB1 standards.

C. Device Plates.

1. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.

2. Device plates on flush mounted outlet boxes where weatherproof plates are not required shall be AISI Type 302 stainless steel, Eaton "93000 series", Hubbell "S series", or Leviton "840nn-40 series"; nylon or polycarbonate, Eaton "5000 series", Hubbell "Pn series", or Leviton "807nn-I series".

3. Device plate mounting hardware shall be countersunk and finished to match the plate.

4. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".

5. Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", or O Z Gedney "FS-1-WDCA.

6. Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA" or Crouse-Hinds "FS031".

7. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eaton "S966", or O Z Gedney "FS-1-GFCA".

8. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell “WP8M” or Thomas and Betts Red Dot “CKMUV”. Covers for ground fault interrupter receptacles shall be Hubbell “WP26M” or Thomas and Betts Red Dot “CKMUV”.

9. Engraved device plates, where required, shall be manufactured by Leviton, or equal.

10. Device plates on PVC conduit fittings shall be Carlon "E98 Series" or Cantex "513300 Series".

D. Wall Switches

1. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".

2. Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".

3. Switches on ac lighting panel load circuits through 277 volts in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be 20 ampere, 120/277 volts. Hazardous area switches shall be factory sealed tumbler switches, Appleton “EDS” or Killark “FXS”.

E. Receptacles

1. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits, and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.

2. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GFRST20I" or Leviton "G5362-I".

3. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "G5362-WTI".

4. Receptacles in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be three-wire, grounding, 20 amperes, 125 volts. Hazardous area receptacles shall be factory sealed, with an integral switch that is only activated when an approved matching plug is fully inserted and rotated into the engaged position. Hazardous area receptacles shall be Appleton “ENR”, Crouse-Hinds “ENR”, or Killark “UGR”.

2.5 JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS

A. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

B. Indoor boxes and gutters in corrosive areas indicated on the Drawings and outdoor boxes and gutters shall be NEMA Type 4X, ABS or stainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

C. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 lbs , shall have rigid handles. Covers larger than 3 by 4 feet shall be split.

D. Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2.6 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified. Lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

B. Electronic Drivers

1. Electronic drivers furnished with LED type lighting fixtures shall be certified as meeting requirements of ANSI C82.77 with a THD level of not more than 20 percent.

2.7 LIGHTING PANELS

A. Each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the Drawings and the following:

B. Cabinet

1. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

C. Circuit Breakers

1. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than **[**10,000**][][]** amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Drawings.

2. Where indicated on the Drawings, circuit breakers shall include arc-fault circuit interrupter (AFCI) and/or ground fault circuit interrupter (GFCI) protection functions. Where GFCI breakers dedicated to protect heat tracing circuits, GFCI breakers shall be configured for equipment protection with a ground fault trip threshold of 30 mA. Otherwise, GFCI breakers shall be configured for personnel protection with a ground fault trip threshold of 5 mA.

D. Buses

1. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.8 SURGE PROTECTIVE DEVICES

A. Scope

1. Surge protective devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

2. Each SPD shall be furnished and installed for the electrical equipment indicated on the Drawings or as specified herein. All new lighting and power panels shall be furnished with an integral SPD.

3. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

4. Power panels shall have SPD's rated for a **[][][]**medium**]** exposure levels.

B. Standards

1. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

a. ANSI/IEEE C62.41 and C62.45;
b. ANSI/IEEE C62.1 and C62.11;
c. IEEE C62.62;
d. National Electrical Manufacturers Association (NEMA LS1 Guidelines);
e. National Fire Protection Association (NFPA 20, 70 [NEC], 75, and 780);
f. Underwriters Laboratories UL 1449 and 1283

2. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

C. Environmental Requirements

1. Operating Temperature: 0°F to +140°F .

2. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

D. Electrical Requirements

1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.

2. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.

3. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.

4. Protection Modes. Four-wire configured systems shall provide, Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide, Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.

5. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

6. UL 1449 Voltage Protection Rating (VPR). The maximum VPR per mode for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
[120/208 3-phase	800 V	800 V	800 V	1200 V**]**

7. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.

8. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

9. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts ac applied.

   At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

   The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

10. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit. When furnished integral to the panelboard, the status indicators shall be viewable when the panelboard door is opened.

E. Installation

1. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

F. Acceptable Manufacturers

1. Integral SPD's shall be manufactured by Eaton, General Electric, or Schneider-Electric. External SPD's shall be manufactured by Eaton, General Electric, Siemens Energy & Automation, Schneider-Electric, or Current Technology. The products of other manufacturers will not be acceptable.

2.9 SEPARATELY ENCLOSED MANUAL STARTERS

A. Separately enclosed manual starters not specified elsewhere shall be provided hereunder. Manual starters shall be provided with thermal overload protection properly sized for the motors served and with a contact and overload in each phase lead. Manual starters shall be mounted in NEMA Type 1 enclosures unless otherwise noted. Manual starters outdoors or indicated to be weatherproof shall have NEMA Type 4 enclosures.

2.10 CONTROL STATIONS

A. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Pilot lights shall be full voltage type with LED lamps. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton "Contender Series" or Killark "Seal-X Series".

B. Emergency Break-Glass Switch

1. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Eaton "10250TGS" or Schneider-Electric "Type 9001K15" with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2.11 SEPARATELY ENCLOSED MAIN CIRCUIT BREAKER

A. Main circuit breaker, MCB-WWTP, shall be service entrance rated, and shall be provided with provisions to terminate cable in the sizes shown on the Drawings. Main circuit breaker shall also be provided with a neutral bond lug suitable to bond the service entrance neutral conductors as shown on the Drawings. The circuit breaker shall be equipped with a main bonding jumper to ground in accordance with the National Electrical Code.

B. Circuit breakers shall be 3 pole, 480 volt, molded-case circuit breakers of not less than **[]]]]**[65,000**]** amperes interrupting rating at 480 volts ac, complete with thermal and instantaneous trip elements. Breaker enclosures shall have NEMA designations appropriate for the locations where they will be installed. NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.

C. Circuit breakers shall have "On", "Off", and "Tripped" indication and padlockable exterior handles.

2.12 DISCONNECT SWITCHES

A. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Drawings.

B. Where indicated on the Drawings, fused switches shall be furnished complete with fuses. Fuse sizing shall be as indicated on the Drawings, as required by the results of the protective device study, or as recommended by the respective protected equipment manufacturer.

C. Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4X enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.

D. Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.

E. All switches shall be UL listed and horsepower [kilowatt] rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

2.13 LIGHTING AND AUXILIARY POWER TRANSFORMERS

A. Separately mounted transformers shall be provided in the phases, kVA, and voltages indicated on the Drawings. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and

enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof. Transformers shall have at least four full capacity voltage taps, two above and two below rated voltage. Transformers shall meet DOE 10 CFR 431 guidelines for energy efficiency.

2.14 LIGHTING CONTACTORS

A. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance. Contactors shall be Schneider Electric 8309LX. Contactor control panels shall be UL 508A listed. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

2.15 PHOTOELECTRIC CONTROLS

A. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

2.16 RELAY ENCLOSURES

A. Relay enclosures shall be furnished as indicated on the Drawings. The enclosure shall have a NEMA designation appropriate for the location where it will be installed. Pilot devices shall be heavy duty, oiltight construction. Relays and timers shall have 120 volt, 60 Hz coils rated for continuous duty in 40 C ambient and 10 ampere, 120 volt ac contacts. Intrinsically safe relays shall be installed within the enclosures in accordance with NEC requirements and shall be Gems "Safe-Pak", B/W "Series 53", or equal.

2.17 ALARM HORN AND BEACON

A. The alarm horns and beacons shall be provided and located as indicated on the Drawings. The beacon shall be 120 VAC, strobe light with clear lens and acrylic dome, Edwards "Model No. 94C-N5" or Federal Signal "Model 371DST". The alarm horn shall be 120 VAC, weatherproof horn, Edwards "Model No. 876-N5" or Federal Signal "Model 350WB". In Class 1, Division 1 and Division 2, group D hazardous areas as indicated on the Drawings the beacon shall be 120 VAC, strobe light with clear lens and acrylic dome, Edwards “Model 116EXMSTC-N5“ or Federal Signal “Model 27XST”. In Class 1, Division 1 and Division 2, group D hazardous areas as indicated on the Drawings the alarm horn shall be 120 VAC, weatherproof horn, Edwards “Model 878EX-N5” or Federal Signal “Model 31X.

2.18 HEAT-TRACED PIPING

A. Outdoor exposed piping shall be heat-traced as indicated on the Drawings and as described herein. Heat tracing shall be sized to maintain pipe temperatures at 40°F with an outdoor ambient temperature of -20°F. Heat tracing shall be of the self-regulating type and shall be suitable for single-phase, 120 volt service. Each run of heat tracing tape shall be provided with a circuit controller, an end-of-line indicating light, junction boxes, mounting accessories, insulation and all other equipment for a complete, properly operating system. Hazardous areas, as indicated on the Drawings and Specifications, shall have heat tracing and associated accessories that are rated for the location. The insulation for all heat tracing shall be as specified in Mechanical Insulation section. Each heat-tracing circuit shall be provided with a microprocessor-based circuit controller to monitor temperature and ground fault current. The controller shall be Chromalox “IntelliTrace ITC Controls Series”, Nelson “CM Series”, Thermon “Genesis Series”, Raychem "DigiTrace 910 Series", or equal. On all plastic pipe equipped with heat tracing, a layer of conducting tape shall be installed on the pipe before heating cable installation and then again following installation of the heating cable.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING, AND COMMISSIONING

A. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3.2 ARC FLASH HAZARD ANALYSIS

A. Contractor shall commission an Arc Flash Hazard Analysis in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified herein. The scope of the analysis, for each site shall include the entire new and existing electrical distribution system, and shall include arc flash labeling for each piece of electrical equipment including lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter sockets, medium-voltage transformers, and other electrical equipment likely to be worked on energized.

B. The scope of the analysis for each site,shall include all existing and new electrical equipment within the facility distribution system, beginning with the electric utility meter socket or service entrance equipment.:

C. The analysis shall calculate the incident energy value and arc flash boundary at defined working distances for all AC, three-phase, 208 volt through 15kV, electrical equipment in accordance with the IEEE 1584 calculation method.

D. AC single-phase equipment, rated 208 volt and above, shall be calculated using single-phase fault current values applied to the three-phase equations in accordance with IEEE 1584.

E. AC single-phase equipment, rated below 208 volt, with a maximum available fault current of 25 kA and a maximum fault clearing time of 2 cycles, shall be analyzed and labelled using the Arc-Flash PPE Categories for Alternating Current Systems, Table 130.7(C)(15)(a), in NFPA 70E (2018).

F. DC system and equipment shall be analyzed and labelled using the Arc-Flash PPE Categories for Direct Current Systems, Table 130.7(C)(15)(b), in NFPA 70E (2018).

G. The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study. Protective-device settings shall be selected to provide the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

H. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system. **[**The Contractor shall be responsible for obtaining the available fault current values from the local electric utility and include the utility correspondence and date in the report for records. The analysis shall not assume bolted fault current values.**]**

I. For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.

J. The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.

K. The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:

1. Equipment name.

2. Three-phase bolted fault current.

3. Arcing fault current.

4. Arcing fault current through the protective device.

5. Protective device clearing the fault.

6. Protective device opening time.

7. Bus gap.

8. Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.

9. Arc flash protection boundary.

L. An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.

M. Arc Flash Analysis Software

1. The Arc Flash Hazard Analysis shall be performed using the latest version of**][**SKM Powertools**]** electrical power system analysis software, without exception. After the final version of the study and analysis are completed and accepted, Contractor shall provide a copy of the electronic computer model files to Owner.

N. Arc Flash Hazard Report.

1. Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared.

2. The report shall include the following information at a minimum:

a. Executive summary.
b. Description of scope and study methodology.
c. Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.
d. Discussion of results and any recommendations.
e. Tabulated results spreadsheet.
f. List of assumptions.
g. One-line diagram(s) from the computer model software showing equipment names and other applicable information.
h. Documentation of software study parameters and configuration settings.
i. Recommended arc flash Personal Protective Equipment (PPE) selection in accordance with NFPA 70E.

3. A bound hardcopy and digital PDF of the final Arc Flash Hazard Analysis report shall be submitted in accordance with the Submittal Procedures section.

4. The final report shall be signed and sealed by a registered Professional Engineer.

O. Arc Flash Labeling

1. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The label template shall be subject to review and acceptance by Engineer. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.

2. Switchgear, motor control centers, and other multi-section equipment shall be provided with a duplicate label for each vertical section.

3. Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

3.3 PROTECTIVE DEVICE STUDY

A. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components starting with the smallest – 480 volt, 3 phase, 60 Hz – circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

B. Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers are sized and set according to the study results.

C. The study shall include, but shall not be limited to, the following:

1. Color-coded printouts of coordination curves prepared with calculation software.

2. A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.

3. Motor starting profiles for all 50 horsepower and larger motors.

4. Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.

5. Generator damage curves and protection, evaluated in accordance with manufacturer recommendations.

6. Coordination curve(s) from the power company, if available.

7. Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.

8. Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications.

9. Adjustable frequency drive settings evaluated in accordance with the manufacturer recommendations and driven equipment requirements.

10. Reduced voltage starter settings evaluated in accordance with the manufacturer recommendations and driven equipment requirements.

D. An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.

E. Contractor shall be responsible for obtaining the following:

1. The coordination curves for relays, fuses, and circuit breakers.

2. Transformer damage curves.

3. Motor and pump data.

4. Generator data.

5. Other applicable information for all new and existing electrical equipment.

F. Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.

G. The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.

H. The protective device report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

3.4 POWER AND SERVICE ENTRANCE INSTALLATION

A. Contractor shall consult the local electric utility regarding their service installation requirements, and shall install the service equipment in compliance with these requirements. Contractor shall install all power service equipment components except for components installed by the utility as directed in the utility service installation requirements.

B. Contact information for the electric utility is as follows:

Name of electric utility	*North Alabama Electric*
Electric utility contact person and telephone number	*Steve Patton, 256-548-0801, spatton@naecoop.com*

C. Contractor shall coordinate details and timing of service entrance installations with the utility. Contractor shall complete and submit service applications to the electric utility as necessary.

3.5 CABLE INSTALLATION

A. General

B. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.

1. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

2. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.

3. Splices may be made only at readily accessible locations.

4. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

5. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

6. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".

7. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.

8. Spare cable ends shall be taped, coiled, and identified.

9. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.

10. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

11. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.

12. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.

3.6 RACEWAY INSTALLATION

A. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, **[]**and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

B. Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.

C. Installation of Interior and Exposed Exterior Conduit

1. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

2. Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:

   a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be **[**rigid aluminum**][]**. Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

   b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.

   c. Conduit installed in all exposed outdoor locations shall be rigid aluminum, rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

   d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight

flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet unless otherwise acceptable to Engineer.

e. Terminations and connections of rigid and intermediate metal conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.

f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

h. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues.

i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid Schedule 80 PVC. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.

j. Rigid Schedule 40 and 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

k. Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

l. Rigid Schedule 40 and 80 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concretetight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.

o. Conduit shall be clear of structural openings and indicated future openings.

p. Conduits through roofs or metal walls shall be flashed and sealed watertight.

q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of

fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.

r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

s. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

u. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

v. Horizontal conduit shall be installed to allow at least 7 feet of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.

x. PVC-coated rigid conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

z. Conduit which turns out of concrete slabs or walls, shall be connected to a 90-degree elbow of PVC-coated rigid steel or aluminum conduit before it emerges. Conduits shall have a matching PVC-coated rigid coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.

aa. Conduit for Heliax type foam dielectric coaxial cable shall be installed as follows:

Heliax Size inches	Minimum Conduit Size inches	Minimum Conduit Bend Radius inches
1/2	1-1/2	10
7/8	2	18
1-1/4	4	22
1-5/8	4	28

D. Underground Conduit Installation

1. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

   a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced as detailed on the Drawings.
   b. Concrete encased conduit shall be **[**PVC utility duct**][**schedule 40 PVC**]**. Conduits shall have PVC-coated rigid steel or aluminum coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.
   c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches above grade, with top crowned and edges chamfered.
   d. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.
   e. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.
   f. Underground conduit bend radius shall be at least 2 feet at vertical risers and at least 3 feet elsewhere.
   g. Underground conduits and conduit banks shall have at least 2 feet of earth cover, except where indicated otherwise.
   h. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.
   i. Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90-degree elbows of PVC-coated rigid steel or aluminum conduit before they emerge.
   j. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
   k. Underground conduits shall be sloped to drain from buildings to manholes.
   l. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

E. Sealing of Conduits

1. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.

2. Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

3. Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

F. Reuse of Existing Conduits

1. Existing conduits may be reused subject to the concurrence of Engineer and compliance with the following requirements:

a. A wire brush shall be pulled through the conduit to remove any loose debris.
b. A mandrel shall be pulled through the conduit to remove sharp edges and burrs.

3.7 WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION

A. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

B. Conduit Boxes and Fittings

1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

2. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.

3. Aluminum device boxes shall be installed in exposed rigid aluminum conduit systems.

4. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

5. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

C. Device Plates

1. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

D. Wall Switches

1. Wall switches shall be mounted 3'-6" above floor or grade.

2. After circuits are energized, all wall switches shall be tested for proper operation.

E. Receptacles

1. Convenience outlets shall be 18 inches above the floor unless otherwise required.

2. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.

3. Welding receptacles shall be surface-mounted 4 feet above the floor.

4. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

5. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

F. Special Outlets

1. Wall thermostats shall be 4'-6" above the floor unless otherwise required. Thermostats on exterior walls shall be suitably insulated from wall temperature.

3.8 EQUIPMENT INSTALLATION

A. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

B. Setting of Equipment

1. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

C. Sealing of Equipment

1. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3.9 GROUNDING

A. General

1. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:
    a. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.
    b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.
    c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch copper disc over the cable. The copper disc shall be installed on the exterior of the wall and shall be a minimum thickness of 12 gauge and have a diameter that is a minimum of 2 inch larger than the diameter of the core hole that the ground cable passes through. The copper disc shall be soldered to the ground cable and caulk shall be applied around the outside edge of the copper disc where it adjoins the exterior wall. Caulk rated for submerged application shall comply with the Joint Sealants section.
    d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches . The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.
    e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.
    f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.
    g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches .

i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.

j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

B. Grounding System Resistance

1. The ground system resistance shall comply with National Electrical Code.

2. The grounding system design depicted on the Contract Drawings is the minimum design required for each building or structure. Each system shall comply with the maximum resistance of **[][**5 ohms**]** to ground. Contractor shall confirm the system grounding resistance with the results of the testing specified herein. Systems exceeding the maximum resistance specified shall be supplemented with additional grounding provisions and retested until the maximum specified resistance is achieved.

C. Grounding System Testing

1. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

2. New Grounding Systems

a. Grounding systems of each new building or structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference connection to the current source probe location. Test results shall be documented on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.

3. Grounding System Test Report

a. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3.10 LIGHTING FIXTURE INSTALLATION

A. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

B. Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3.11 HEAT-TRACED PIPING INSTALLATION

A. Factory inspections and tests for heat tracing cables shall include but are not limited to the following:

1. Testing shall be done in accordance with IEEE 515 test section and applicable manufacturer's standards.

2. Megger test of heater cables shall be at jobsite when received before installation.

3. Megger test of heater cables shall be performed after installation, but before insulation is applied.

4. Megger test of heater cables shall be performed after insulation has been installed.

5. All three of the above field megger readings shall be greater than 20 megohms. If any heater cable does not pass the megger test it shall be replaced at the Contractors expense.

6. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the Engineer.

3.12 MODIFICATIONS TO EXISTING EQUIPMENT

A. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

B. Demolition

1. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

End of Section

STANDARD SPECIFICATIONS

REFERENCE:	UL 83, ICEA S-95-658 (NEMA WC70).
CONDUCTOR:	Solid, uncoated copper. Wet/dry maximum operating temperature 90°C.
INSULATION:	Polyvinyl chloride, UL 83, Type THHN and THWN-2, ICEA S-95-658.
SHIELD:	None.
JACKET:	Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 83.
FACTORY TESTS:	Cable shall meet the requirements of UL 83 for Type THHN and THWN-2.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	µm	in.	mm
12	4.0	1	0.015	380	0.14	3.56
10	6.0	1	0.020	510	0.17	4.32

*The average thickness shall be not less than that indicated above. The minimum thickness shall not be less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, THWN-2 or THHN, conductor size, and 600 volt.

600 Volt, Single Conductor Lighting Cable (600-1-PVC-THHN-THWN-2)

BLACK & VEATCH	Cable Data	Figure 1-26 0511

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.

INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.

SHIELD: None.

JACKET: None.

FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	7	0.030	760	0.15	3.81
12	4.0	7	0.030	760	0.17	4.32
10	6.0	7	0.030	760	0.19	4.83
8	10.0	7	0.045	1140	0.25	6.35
6	16.0	7	0.045	1140	0.28	7.11
4	25.0	7	0.045	1140	0.34	8.64
2	35.0	7	0.045	1140	0.40	10.16
1	40.0	19	0.055	1400	0.46	11.68
1/0	50.0	19	0.055	1400	0.50	12.70
2/0	70.0	19	0.055	1400	0.55	13.97
4/0	95.0	19	0.055	1400	0.66	16.76
250	120.0	37	0.065	1650	0.73	18.54
350	185.0	37	0.065	1650	0.83	21.08
500	300.0	37	0.065	1650	0.96	24.38
750	400.0	61	0.080	2030	1.20	30.48
1,000	500.0	61	0.080	2030	1.32	33.53

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable (600-1-XLP-XHHW-2)

BLACK & VEATCH	Cable Data	Figure 2-26 0511

STANDARD SPECIFICATIONS

REFERENCE:	UL 66, UL 1277.
CONDUCTOR:	16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
INSULATION:	Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.
LAY:	Twisted pair with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.
SHIELD:	Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.
JACKET:	Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66. Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.
CONDUCTOR IDENTIFICATION:	One conductor black, one conductor white.
FACTORY TESTS:	Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	**μm**	**in.**	**mm**
Single Pair	0.045	1140	0.34	8.64

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.

600 Volt, Single Pair, Shielded Instrument Cable (600-SINGLE-PAIR-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 4-26 0511**

STANDARD SPECIFICATIONS

REFERENCE:	UL 66, UL 1277.
CONDUCTOR:	16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
INSULATION:	Polyvinyl chloride, not less than 15 mils (380 µm) average thickness; 13 mils (330 µm) minimum thickness, UL 66, Type TFN.
LAY:	Twisted triad with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.
SHIELD:	Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.
JACKET:	Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 66. Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.
CONDUCTOR IDENTIFICATION:	One conductor black, one conductor white, one conductor red.
FACTORY TESTS:	Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	**µm**	**in.**	**mm**
Single Triad	0.045	1140	0.35	8.87

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single triad, and voltage class.

600 Volt, Single Triad, Shielded Instrument Cable (600-SINGLE-TRIAD-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 5-26 0511**

STANDARD SPECIFICATIONS

REFERENCE:	ICEA S-95-658 (NEMA WC 70).
CONDUCTOR:	Stranded, uncoated copper. Maximum operating temperature 90°C.
INSULATION:	Cross-linked polyethylene, ICEA S-95-658.
GROUND:	Copper conductor sized per NEC with green insulation.
SHIELD:	Cable assembly: Copper tape or aluminum foil-polyester tape, shield applied to achieve 100 percent cover over insulated conductors.
JACKET:	Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.
FACTORY TEST:	Cable shall meet the requirements of ICEA S-95-658, UL1277 and IEEE Standard 1202 ribbon burner flame test.

Cable Details

Size		Number of Strands	*Conductor Insulation Thickness		**Assembly Jacket Thickness		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	mm	in.	μm	in.	mm
12	4	7	0.060	1.52	0.060	1520	0.66	16.80
10	6	7	0.060	1.52	0.060	1520	0.71	18.14
8	10	7	0.070	1.78	0.060	1520	0.93	23.74
6	16	7	0.070	1.78	0.080	2030	1.04	26.40
4	25	7	0.070	1.78	0.080	2030	1.21	30.67
2	35	7	0.070	1.78	0.080	2030	1.35	34.40
1	40	7	0.070	1.78	0.080	2030	1.35	34.40
1/0	50	19	0.090	2.29	0.080	2030	1.70	43.07
2/0	70	19	0.090	2.29	0.080	2030	1.77	44.94
4/0	95	19	0.090	2.29	0.110	2800	2.02	51.34
250	120	37	0.105	2.67	0.110	2800	2.30	58.49
350	185	37	0.105	2.67	0.110	2800	2.63	66.70
500	300	37	0.105	2.67	0.110	2800	3.12	79.26

*The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

**The average thickness shall be not less than indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, RHW, Type TC, conductor size, and voltage class.

2000 Volt, 3 Conductor Adjustable Frequency Drive Cable (2000-3-AFD-XLP-PVC-SH-TC)

BLACK & VEATCH	Cable Data	Figure 15-26 0511

Project and Location _____ Project No. _____

Circuit Designation _____ Date _____

DC TEST DATA

Time in Minutes After 100% Test Voltage Is Applied	Current, µA		
	Phase A	Phase B	Phase C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
kV dc after 1 min Decay			

DC Test Voltage _____

Cable Installation: New ____ Used ___ Years____

Cable: Size _____ Length: _____

Oper. kV _____ Grounded _____ Ungrounded_____

Rated Cable Voltage _____

Insulation Wall _____
(Type & Thickness)

Conductor Jacket Wall _____
Type & Thickness)

Shield _____
(Type)

Cable Manufacturer _____

Temperature _____ Humidity_____

Type of Termination _____

Type of Splice & Location_____

_____

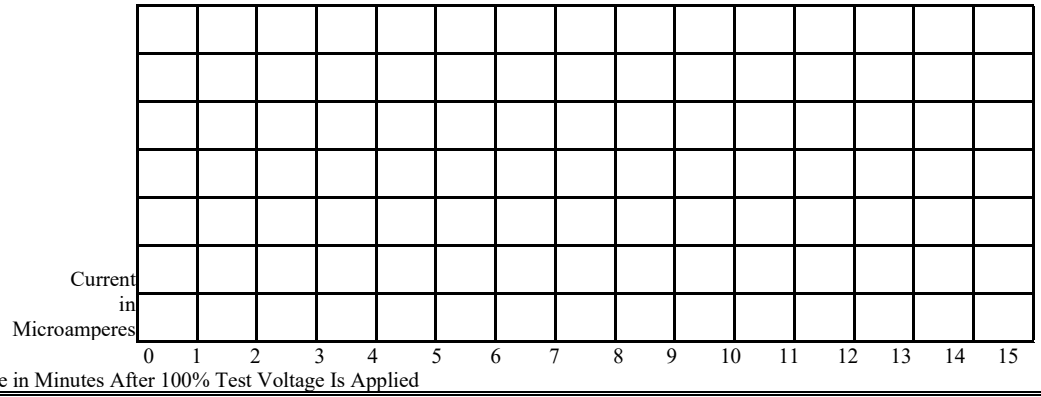
Remarks_____

100 Microamperes (µA) = 0.1 Milliampere

APPLICATION OF TEST VOLTAGE

The initially applied direct-current voltage shall be not greater than 3.0 times the rated alternating-current voltage. The rate of increase from the initially applied voltage to the specified test voltage shall be not over 100 percent in 10 seconds nor less than 100 percent in 60 seconds. The duration of the direct-current voltage test shall be 15 minutes for shielded cables and 5 minutes for nonshielded cables.

Test Curve



NOTES:
1. Plot results of tests on all three phases on this graph.
2. Assign and indicate values for each division on the microamperes scale as required for the circuit being tested.

Cable Test Data Form

BLACK & VEATCH	**Cable Data**	**Figure 16-26 0511**

SECTION 26 05 83 - ELECTRICAL EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of electrical equipment.

1.2 GENERAL

A. Equipment specified to be installed under this section shall be erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. The electrical equipment identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

C. Coordination

1. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 14 days prior to the need for manufacturer's field services furnished by others.

2. Submittals for equipment furnished under the original procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. When sills are required for electrical equipment, they shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

B. Storage

1. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Product Storage and Handling Requirements section, and in accordance with manufacturer's written instructions, until installed in the Work.

Equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Contractor shall keep the equipment clean and dry at all times. Openings shall be plugged or capped (or otherwise sealed by packaging) during temporary storage.

C. Handling

1. Electrical equipment shall be moved by lifting, jacking, or skidding on rollers as described in the manufacturer's instructions. Special lifting harness or apparatus shall be used when required. Lifting and jacking points shall be used when identified on the equipment. Contractor shall have required unloading equipment on site to perform unloading work on the date of equipment delivery.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING, AND COMMISSIONING

A. All installation work shall be in accordance with manufacturer's written instructions.

B. All material, equipment, and components specified to be installed according to this section shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

C. Electrical equipment cubicles and vertical sections shall be installed plumb and level. Drawout equipment carriages, circuit breakers, and other removable components shall operate free and easy without binding or distortion.

D. Unless otherwise indicated or specified, all indoor floor-mounted electrical equipment and control cabinets shall be installed on concrete equipment pads four inches [102 mm] in height.

E. Indoor metalclad switchgear shall be bolted to steel floor channels which are installed level and flush with the top of the concrete floor or equipment pad.

F. Outdoor metalclad switchgear and interrupter gear with integral floor channels or beams shall be secured to concrete pads with anchor bolts and clips.

G. Motor control centers with integral floor sills shall be secured to concrete floors or equipment pads with anchor bolts.

H. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

I. Cleaning

1. All deposits of oil, grease, mud, dirt or debris shall be cleaned from the electrical equipment following installation and field wiring. A detergent water based solution, or other liquid cleaners not harmful to material or equipment finishes, shall be used as recommended by the manufacturer.

End of Section

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SECTION 26 24 23 - 600 VOLT CLASS MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers motor control center (MCC) equipment which shall be furnished and installed as specified herein and as indicated on the Drawings. Motor control centers shall meet the following requirements, and the design conditions and features specified herein.

B. Motor control centers shall be designated and shall be located as follows:

Designation(s)	*MCC-WWTP*
Location of motor control center(s)	*Chemical Building*

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.

B. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

E. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.

F. Governing Standards

1. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

   a. NEMA ICS 18
   b. UL 845.

2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

3. Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of the Contractor. In the event, no third-party testing laboratory provides the required listing; an independent test shall be performed at the Contractor's expense. Before testing, the Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.

G. Nameplates

1. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch high letters for compartment identity and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

H. System Characteristics

1. This equipment will be connected to a power system with characteristics as specified below.

Voltage	**[**480**]** V
Frequency	**[**60**]** Hz
Type	**[**Three phase**]**

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

a. Motor Control Center
1) Elevation, plans, and weight.
2) Unit wiring diagrams showing devices, connections, and terminal designations. Wiring diagrams should clearly identify field connections. Provide cable termination range information for all power terminals.
3) Interconnection diagrams.
4) Control schematic diagrams.
5) Circuit breaker time-current characteristic curves.
6) **[**Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.**]**

b. Seismic Design Requirements
1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SPARE PARTS

A. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed. Spare parts shall be provided as follows:

Spare Parts	Quantity
[Fuses	100% replacement set**]**
[Indicating lamps	100% replacement set**]**

1.5 PROTECTIVE DEVICE STUDY

A. A protective device settings study of the power distribution system will be conducted in accordance with the Electrical section. The initial equipment drawing submittal shall include the circuit breaker coordination curves for **[**the main breaker(s), **][]**the largest circuit breaker utilized in a combination starter and the smallest circuit breaker provided as a part of the motor control center assembly.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Motor control centers shall be equipped to be handled by a crane. Where cranes are not available, control centers shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The equipment shall be manufactured by ABB, Allen-Bradley, Eaton, Schneider-Electric, or Siemens without exception.

2.2 CONSTRUCTION

A. Each control center shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the Drawings or specified herein. End sections shall include provisions for main, ground and neutral bus extensions and installation of future vertical sections.

B. Motor control center wiring shall be NEMA Class IIS and NEMA Type **[**B**]** . Construction shall be as specified below.

Tag number(s)	*MCC-WWTP___*
Bus bracing, circuit breaker and combination motor starter rating	**[**42,000**]** A
Horizontal bus rating	**[**600**]** A
Service entrance rated	**[**No**]**

Cable entry	[Top and bottom]
Enclosure type	[NEMA Type 1 gasketed]]
Main SPD exposure level	[Medium-high]

C. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

D. Vertical Sections

1. The control center shall consist of standardized, freestanding structures bolted together to form a single dead-front panel assembly containing combination motor control units; feeder units; transformers; lighting panels; and metering, relaying, and interlocking, and miscellaneous control devices, as indicated on the Drawings. A removable lifting angle shall be mounted on the top of each shipping group. Removable front and rear bottom channel sills shall extend the full width of the motor control center.

2. Each vertical section shall be 90 inches high and not less than 20 inches wide. Each 20 inch wide standard section shall have all necessary hardware and busing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Removable rear plates shall be sectionalized so that it is unnecessary to handle any plate larger than the section width or one-half the section height.

3. A metal barrier extending the full height and depth of the section shall be provided to isolate each section from the next section.

E. Compartmented Units

1. Each vertical section shall be constructed of modular components of various sizes. The modular components shall be designed to accommodate not more than six Size 1 or Size 2 full voltage combination motor starters per vertical section.

2. Removable circuit breaker and motor starter units shall be provided with a mechanical interlock to prevent insertion or withdrawal when in the "on" position.

3. Individual motor starter units, feeder breaker units, transformers, lighting panels, and control device compartments shall be isolated from each other by barriers of metal or a suitable insulating material.

4. Each vertical section shall have a vertical-wiring trough for power and control wiring, and wiring troughs on top and bottom, which are continuous through the entire control center. Wire ties shall be provided in the vertical wireways unless the wireways are separated from the plug-in units by a permanent wall.

F. Wiring Labels and Terminal Blocks

1. All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal number.

2. All starter units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

G. Busing

1. The horizontal main bus and the vertical bus extensions shall be tin-plated copper mounted on supports formed of materials having high dielectric strength, low moisture absorbency, and high impact strength. The main bus shall extend the full length of the motor control center and shall have provisions for splicing additional sections onto either end. Both horizontal and vertical busing shall be braced against forces resulting from fault current.

2. The vertical bus connecting an incoming power feeder cable shall have the same ampere rating as the main horizontal bus. Each vertical bus extension shall be rated for the total connected load of the vertical section.

3. A tin-plated copper ground bus rated 300 amperes shall extend through the entire control center and shall be located where it will not interfere with pulling of external cable. Grounding connections shall be accessible from the front. The ground bus shall be provided with six 0.38 inch holes for each vertical section to accept ground lugs for any loads requiring a ground conductor. A solderless connector shall be provided on the ground bus in each end section for an external ground cable, sized from 1/0 AWG to 250 kcmil .

4. Each vertical section shall have a vertical ground bus. The plug-in units shall engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected.

H. Isolation of Buses

1. The main bus shall be isolated from the horizontal wiring trough. The entire vertical bus assembly shall be enclosed within grounded steel or glass filled polyester barriers. The barriers shall have openings for power stabs of plug-in units. Shutters shall be provided to close the openings when units are removed.

I. Combination Magnetic Starters

1. As indicated on the Drawings, control center starters shall be breaker combination, magnetic, reduced voltage, or across-the-line type as follows:

a. Starters shall be 3 phase, 60 Hz contactors with overloads, a 120 volts ac coil, a dry type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

b. Contactors shall be NEMA rated and have an 8 hour current rating in accordance with the latest NEMA standards. Contactors of reversing or multispeed starters shall be mechanically and electrically interlocked.
c. One NO and one NC spare interlock contacts, whether on the starter or a relay, shall be wired separately to the unit terminal board.
d. **[**A 3 phase ambient-compensated eutectic alloy style thermal overload relay with external manual reset shall be furnished with each starter.
e. An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.
f. Contractor shall match control transformers, overloads, and minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the Drawings. Overload relay elements shall be sized to reflect reduced motor current caused by load-side power factor correction capacitors.
g. Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

J. Contactors

1. Contactors for control of bus voltage loads other than motors shall be the same as contactors for combination magnetic starters, except overloads will not be required. Mechanically held contactors shall have 120 volts ac coils with disconnecting contacts. Other contactors shall have 120 volt, continuous duty coils and contacts where indicated on the Drawings.

K. Relays and Timers

1. Auxiliary relays and timers shall have 120 volt, 60 Hz coils for continuous duty in 40°C ambient, and 10 ampere, 120 volts ac contacts. Auxiliary relays shall be NEMA rated.

L. Control Switches and Pilot Lights

1. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.

M. Circuit Breakers

1. Control center disconnects shall be three pole, single-throw, 600 volt, molded-case air circuit breakers. Circuit breakers of combination starters shall be magnetic motor circuit protector type. Feeder circuit breakers shall be thermal-magnetic type and shall be manually operated, with quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Thermal elements shall trip the breaker at 125 percent of trip rating. The instantaneous elements of 125 ampere to 200 ampere frame breakers shall be adjustable and shall be set at 800 percent of trip rating.

2. Main circuit breakers and feeder circuit breakers 225 amperes and larger shall be furnished with a solid-state trip unit complete with built-in current transformers. The

ampere rating of the trip unit shall be as indicated on the Drawings. The trip unit shall have adjustable settings for continuous amperes, short-time, and instantaneous pickup. The trip unit shall be provided with long-time and short-time delay trip time adjustment for better system coordination.

N. Surge Protective Devices

1. Scope

a. Surge Protective Devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.
b. SPD's shall be furnished and installed for the electrical equipment indicated on the Drawings and designated in this section and as specified herein. SPD's shall be installed integral to each MCC and MCC panelboard.

2. Standards

a. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:
1) ANSI/IEEE C62.41 and C62.45;
2) ANSI/IEEE C62.1 and C62.11;
3) NEMA LS1;
4) NFPA 20, 70, 75, and 78;
5) UL 1449 and 1283

b. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

3. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F .
b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

4. Electrical Requirements

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), Line-to-Line (L-L), and Neutral-to-Ground (N-G) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and

shall be no less than listed in the following table. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

	L-N	L-G	N-G	L-L
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
[480 V 3W		1200 V		2000 V]

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.

h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200kA symmetrical fault current with 600 volts ac applied.
At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.
The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.

5. Warranty

a. The manufacturer shall provide a minimum Five Year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

6. Installation

a. Each SPD shall be installed according to the manufacturer’s recommendations. If possible for the integral units, provide direct bus connections.

7. Accessories

a. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL1449 listed as such, and the UL1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and

capable of withstanding the published maximum surge current magnitude without failure or damage to the switch.

O. Incoming Line Metering Compartment

1. The incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Phase currents, phase voltages, watts, vars, power factor, frequency, watt-hours, watt demand , and total harmonic distortion waveforms shall be available for display. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of at least one serial (RS-485/Modbus RTU) and at least one Ethernet 10/100 Base-T communication port (Modbus TCP or Ethernet/IP) for remote monitoring. The digital power meters shall be Allen-Bradley “Power Monitor 5000”, Eaton "Power Xpert Meter 4000", Multilin "EPM9700", Schneider-Electric "PowerLogic Model ION9000", or Siemens “9410 Series”.

2. Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control center and as indicated on the Drawings.

3. The metering package shall be compatible with the metering system software and metering system network as specified in the Electrical section. Contractor shall furnish and install applications software for origination and display of all metering unit data and microprocessor-based trip-unit data in accordance with the Electrical section.

P. Miscellaneous

1. Other items indicated on the Drawings shall conform to the applicable provisions of NEMA ICS 2 and UL 845.

Q. Shop Painting

1. All iron and steel surfaces, except stainless steel and machined surfaces, shall be plated or shop painted with the manufacturer's standard coating. Finish color for both indoor and outdoor equipment shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2. The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

2.3 SHOP TESTS

A. The complete control center shall be tested at the factory. All circuits, including power and control, shall be given dielectric tests in accordance with NEMA ICS 2-322.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An installation check by an authorize representative of the manufacturer is not required.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.3 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

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SECTION 26 29 24 - ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers pulse width modulated (PWM) type adjustable frequency drives (AFD) for the equipment and locations as specified. AFDs shall meet the design conditions and features specified herein.

Driven equipment Specification number.	43 24 13
Unit designations.	COLW-AFD-1510, COLW-AFD-1520

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Equipment provided under this section shall be fabricated as specified in this section and as shown on the schematics and one line diagrams on the Drawings.

C. Unless otherwise indicated on the Drawings, one adjustable frequency drive, complete with all required control components, shall be furnished for each motor.

D. AFDs shall be designed, manufactured, supplied, and warranted as a complete system by the AFD manufacturer. Fabrication and assembly of the drive system not directly controlled by the AFD manufacturer will not be acceptable.

E. Coordination

1. The design of the adjustable frequency drive shall be coordinated with the driven equipment. Contractor shall be responsible for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

2. **[**The manufacturer of the driven equipment shall be responsible for furnishing the adjustable frequency drive.

F. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

G. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

H. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

I. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

J. Governing Standards

1. The adjustable frequency drive shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, ANSI, UL, and IEEE, and shall be designed for installation in accordance with the NFPA 70.

2. The equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor’s expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

K. Nameplates

1. Nameplates with the description and designation of each control or indicating device shall be provided. Unless specified otherwise, each drive enclosure shall be provided with a nameplate bearing the unit designation as indicated above. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch high letters for the drive designation and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the enclosure shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.3 DESCRIPTION

A. The AFD shall produce an adjustable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

B. Six-Pulse Drives

1. Drives for motors rated below 100 horsepower, shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

2. The drive inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The drive shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1.4 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the drive shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

2. Name of manufacturer.

3. Types and model numbers.

4. Rated drive input kVA and output kVA.

5. Percent efficiency at 100 percent speed and 60 percent speed.

6. Maximum Btu [kJ] heat release data and verification of the drive cooling requirements.

7. Total weight and lifting instructions, height, mounting, and floor space required.

8. Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.

9. Schematics, including all interlocks.

10. Detailed wiring diagrams, including all internal and external devices and terminal blocks. Wiring diagrams should clearly identify both internal and external (field) wiring and

provide wire terminals that are capable of landing cable sizes and types indicated in the Drawings.

11. Locations and sizes of electrical connections, ground terminations, and shielded wires.

12. List of diagnostic indicators.

13. List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.

14. List of features and options selected for provided AFD

15. List of spare parts to be furnished.

16. Input line protection model numbers and manufacturer's data sheets.

17. Output filter model number and manufacturer's data sheets.

18. UL 61800-5-1 Certificate of Compliance for short circuit current rating.

19. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

20. Certification of conformal coating on all printed circuit boards.

21. Provide a catalog cut sheet and time current curves for the main circuit breaker.

1.5 OPERATION AND MAINTENANCE DATA AND MANUALS

A. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section.

B. Operation and maintenance manuals shall include the following:

1. Manufacturer's operation and maintenance manual for each size of adjustable frequency drive.

2. Manufacturer's standard manuals for each size and type of transformer, line reactor, and filter.

3. Schematics, wiring diagrams, and panel drawings in conformance with construction record.

4. Model numbers and up-to-date cost data for spare parts.

5. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.

6. Connection data to permit removal and installation of recommended smallest field-replaceable parts.

7. Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.

C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.6 SPARE PARTS

A. The drive manufacturer shall provide spare parts for each type and size of drive supplied. The spare parts shall include at least one complete set of all plug-in components for each size and type of drive, and shall include the following:

1. Power fuses

2. Control fuses

3. Indicating lights

4. Rectifier power semiconductors

5. Inverter power semiconductors

6. One of each type printed circuit board and gate firing board

7. Other field-replaceable component parts

B. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1.7 PROTECTIVE DEVICE STUDY

A. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:

1. Protective relay coordination curves for each solid-state trip device.

2. Time current curves for each circuit breaker.

B. Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All drives shall be pulse-width modulated type, as manufactured by ABB, Eaton, Rockwell Automation, Schneider-Electric, or Toshiba without exception. The products of other manufacturers will not be acceptable.

B. All adjustable frequency drives shall be a product of the same manufacturer.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Performance

1. The adjustable frequency drive controller shall be of sufficient capacity and shall produce a quality output waveform for stepless motor control from 10 to 100 percent of base speed. The adjustable frequency drive shall be suitable for loads and shall have voltage ratings as follows:

Unit designations	COLW-AFD-1510, COLW-AFD-1520
Load type	**[**Variable torque (VT)**]**
Input voltage	**[**480 volt, 3 phase**]**

2. The adjustable frequency drive shall be suitable for operation at an elevation below 3300 ft , and shall meet the following ratings and parameters:

Input frequency	60 Hz
Input voltage and frequency variation	±10 percent voltage variation, ±2 Hz; imbalance, 2 percent maximum. Continued operation with additional momentary 25 percent voltage dip of 0.5 second duration from nominal input voltage level.
Minimum drive efficiency	95 percent at 100 percent speed, 90 percent at 60 percent speed.
Ambient temperature	0 to 40°C.
Relative Humidity	0 to 95 percent non-condensing.
Displacement Power Factor	95 percent or higher throughout the entire operating speed range, measured at drive input terminals.

Drive service factor	1.0.
Overcurrent capability	110 percent for 1 minute for variable torque
Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, linear over the entire range of the unit for constant torque drives; except under voltage boost condition.
Acceleration/deceleration time	Adjustable over a range that meets the requirements of the drive equipment.
Output speed regulation	0.5 percent.
Output frequency stability	0.5 percent of nominal.

Specifier. Insert a paragraph describing other enhanced or non-standard features.

B. Adjustments

1. The following drive adjustments shall be provided:

a. Maximum speed.
b. Minimum speed.
c. Linear acceleration time.
d. Linear deceleration time.
e. Volts/Hz ratio; linear, squared, and automatic settings.
f. Voltage boost.
g. Process follower gain, offset, and bias.
h. Torque limit.
i. Critical frequency avoidance with adjustable bandwidth.

C. Fault Protection

1. Design of the power circuit shall include provisions for protection against fault conditions as follows.

2. Input Protection

a. The drive assembly shall be UL 61800-5-1 certified. A UL Certificate of Compliance shall be submitted to confirm product compliance with UL 61800-5-1 and to indicate the short circuit current rating. The short circuit current rating shall meet or exceed the available short circuit current indicated on the Drawings.
b. Solid state instantaneous overcurrent trip set at 180 percent.
c. Adjustable overvoltage and undervoltage protection with automatic restart.
d. Phase loss and reverse phase trip with manual restart.
e. AC line, phase-to-phase transient voltage surge suppression utilizing metal oxide varistors. Drive shall meet the requirements of IEEE C62.41.
f. Power device snubbers.
g. Power devices rated 2.5 times line voltage.
h. Instantaneous overcurrent.

i. Static overspeed (overfrequency) protection.
j. DC bus overvoltage trip.
k. Components and labeling that comply with UL 61800-5-1 requirements. Drives shall be equipped with an automatic discharge circuit to deplete the charge on the DC capacitor bank to less than 50 volts within 60 seconds after main input power is removed. Labels indicating derivative voltage sources and required wait time for servicing after power removal shall be placed on all applicable enclosures.
l. Control logic circuit malfunction indication.

3. Output Protection

a. Inverse-time motor overload protection adjustable from 10 percent to 100 percent.
b. Overvoltage protection.
c. Overfrequency protection.
d. Short circuit protection (three phase, phase to phase, and ground fault protection).
e. Protection against opening or shorting of motor leads.
f. Static overspeed protection.
g. Stall protection on overload with inverse time overcurrent trip, adjustable current limit from 10 percent to 120 percent.
h. Individual transistor overtemperature and overcurrent protection.

2.3 CONSTRUCTION

A. Construction requirements shall be as follows and as specified below:

Unit designations	COLW-AFD-1510, COLW-AFD-1520
Cable entry	Top
Cable exit	Top
Enclosure type	NEMA Type 1

B. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

C. Fabrication and Assembly

1. The adjustable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer, or a manufacturer approved assembly center under the direction and control of the drive manufacturer; systems fabricated, assembled, and supplied in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.

2. Input line reactors, fuses, circuit breakers, and filters, where required, shall be mounted within the drive enclosure, without exception. Isolation/voltage matching transformers, where required, may be enclosed separately from the remaining drive equipment.

3. The adjustable frequency drive system shall be designed to fit in the space indicated on the Drawings.

D. Wiring

1. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. Where wireway is used, they are to be mounted to the panel surface with a continuous run of 3M brand, or equal, industrial two-sided adhesive strip. For 12 AWG wire sizes and smaller, and in bundles of six or less, wire tie-down square mounting straps shall be permitted. Tie-down mounts shall be installed at 8" increments or less. All mounting surfaces shall be pre-cleaned with isopropyl alcohol to ensure proper adhesion over the life of the equipment.

2. Terminal blocks shall be non-brittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.

3. All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.

4. Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.

5. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.

E. Enclosures

1. The drive shall consist of factory mounted and wired components within an enclosure, arranged so no electrically live components, terminals, or conductors are accessible on the front panel or door when the enclosure door is open.

2. The complete drive package, including accessories, shall fit into the space indicated on the Drawings.

3. Freestanding panels shall be suitable for mounting on a concrete pad and shall include provisions for anchoring to the supporting structure. Suitable lifting facilities shall be provided for handling and shipment.

4. Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.

F. Printed Circuit Boards

1. All printed circuit boards shall be sprayed on both sides with a conformal coating. The conformal coating shall be a part of the AFD manufacturing process and shall be selectively applied to the circuit board connections only. Heat sinks and resistors on the circuit board shall not be coated. Conformal coating shall protect the printed circuit board components against chemically reactive environmental substances in accordance with IEC 60721-3-3 Table 4, Class 3C2.

2. All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.

G. Shop Painting

1. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be manufacturer's standard color. Dry film thickness of the finish coat shall be at least 4 mils. Field painting, other than touch up, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.

2. All intermediate and finish coating materials shall be fumeproof and suitable for a wastewater treatment plant atmosphere that contains hydrogen sulfide. Documentation verifying that the coating material is fumeproof shall be submitted. Coatings shall be lead-free and mercury-free.

2.4 OPTIONAL EQUIPMENT

A. AC Line Reactors

1. Each six-pulse AFD, where isolation/voltage matching transformers are not used, shall be supplied with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the AFD input power devices. AC line reactors shall be factory mounted and wired within the AFD enclosure. AC line reactors shall be K-rated per IEEE C57-110 and shall be TCI Model KLR, or equal.

B. Harmonic Filters

1. Unless additional harmonic filters are required to comply with the total harmonic distortion limits specified herein, at a minimum the following AFDs shall be furnished with harmonic filters.

Cooling Water Pump Drives	COLW-AFD-1510, COLW-AFD-1520

2. The AFD manufacturer shall design and provide the required filters. The harmonic filters shall utilize an interlocking contactor that shall be automatically operated by the AFD run circuit. The AFD manufacturer shall be responsible for the complete filter unit, including the filter contactor. Harmonic filters shall be TCI Harmonic Guard HGL Series, or equal.

C. Isolation/Voltage Matching Transformers

1. Transformers furnished with AFDs to provide the required operating voltage shall be constructed in accordance with applicable NEMA and ANSI standards. Transformer voltages shall be as indicated on the Drawings unless otherwise required by the adjustable frequency drive. Transformers shall have Class B, F, or H insulation systems. Terminal compartments shall be front-accessible and shall have adequate space for minimum bending radii of the cables to be terminated. The transformers shall be UL listed and shall be provided with a K rating of 15 in accordance with IEEE C57.110.

2. Transformers rated 15 kVA and lower shall be indoor/outdoor, totally enclosed type, with sound levels generated by each transformer not to exceed 45 dB.

3. Transformers rated higher than 15 kVA shall be indoor/outdoor, self-air-cooled type with dripproof enclosures and ventilating openings, in accordance with NEMA and NEC requirements. The ventilating openings shall be located to provide adequate cooling even with other equipment located on both sides. Sound levels generated by each transformer shall not exceed 60 dB.

2.5 CONTROLS

A. Features

1. Each drive shall include the following features in addition to those indicated on the Drawings:

a. A door mounted membrane keypad with integral two-line, 24 character minimum LCD display that is capable of controlling the AFD and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad.
b. Control switches and pilot lights shall be provided as indicated on the schematic diagrams. Manual-automatic and start-stop controls included as features of the drive keypad shall be password protected or disabled to prevent override of control switches and safety interlocks shown on the schematic diagrams.
c. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.
d. Microprocessor-based regulator. Nonvolatile memory modules shall have a useful life of at least 20 years without requiring battery or module replacement.
e. Input thermal-magnetic molded-case circuit breaker disconnect with interrupting capacity rated in RMS symmetrical amperes as required, and labeled in accordance with UL standard 489. The disconnect shall be mounted inside the controller

enclosure and shall have door interlocks and a handle with provisions for padlocking in the "Off" position.

f. Manual speed adjustment.

g. Indications of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by full voltage type LED pilot lights. Lamps shall be easily replaceable from the front of the indicating light.

h. Elapsed time meter.

i. Speed indication - calibrated in percent rpm.

j. Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity as required by external devices indicated on the Drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.

k. Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Terminals shall be provided for control wiring from motor temperature switches, or a motor protection relay located in the drive enclosure.

l. Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.

m. Accept a remote 4-20 mA speed control signal.

n. Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.

o. Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be furnished with each drive. Additional interlock contacts shall be provided as indicated on the Drawings.

p. Drive fault and run status contacts for remote indication, rated 5 amperes at 120 volts ac.

q. Speed droop feature, which reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

r. Individual adjustable speed profile settings for start, stop, entry, slope, and minimum and maximum speed points.

s. Coast, controlled ramp, or dc injection selectable modes of stopping.

t. Adjustable PWM carrier frequency. The inverter output section shall be provided with adjustable PWM carrier frequency from 500 Hz to at least 8 kHz.

u. Noise level of installed equipment shall not exceed 85 dB, as measured by an appropriate calibrated instrument. The required sound level limit shall be met at a minimum of four locations, each not more than 3 feet above the floor and not more than 10 feet from the equipment. This requirement shall apply to all drives, motors, filters, reactors, and transformers supplied with the drive.

B. Diagnostics

1. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur simultaneously, the

diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 6 events.

2.6 TESTING

A. All power switching components shall be pre-run under anticipated operating temperature and load conditions. Any alternative testing procedures shall be submitted and pre-approved before proceeding.

B. Factory Testing

1. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 4 hours before it is shipped.

2. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.

3. A test report summary indicating satisfactory final test results shall be submitted to Engineer before shipment of the equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.3 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

B. Up to *4* employees of Owner, shall be trained in the proper operation, troubleshooting, and maintenance of the equipment. Training shall be conducted by a qualified representative, and shall consist of combined classroom and hands-on instruction. Training shall be conducted at a place and time mutually agreeable to Owner and the drive manufacturer.

End of Section

SECTION 26 32 13 - ENGINE-GENERATORS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing of one diesel fueled engine-driven electric generator unit designated herein.

Number of Engine-Generator.	1
Engine-Generator tag numbers.	GEN-5000
Engine-Generator location.	Waste Water Treatment Plant

B. The engine-generator shall be located outdoors in its own weatherproof sound attenuated enclosure as indicated on the Drawings.

C. The Engine-Generator Supplier shall be fully responsible to furnish a complete and coordinated skid mounted package system including engine-generator, generator line circuit breaker, generator control sections, exhaust silencer, batteries and chargers, sub-base fuel storage tank, emergency shutdown control station, and all accessories as required for a complete operating system.

D. For proper operation and coordination, the Engine-Generator Supplier shall furnish the automatic transfer switch as indicated on the Drawings and as specified in the Bypass-Isolation Automatic Transfer Switch Section.

1.2 GENERAL.

A. Equipment furnished under this section shall be assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. General Equipment Stipulations.

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

C. Metrological and Seismic Design Requirements.

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria Section.

D. Coordination.

1. All equipment specified in this section shall be furnished through a single engine-generator manufacturer who shall be responsible for the design, manufacture, coordination, and proper installation and operation of the entire system.

2. The engine-generator unit shall be a standard product of the manufacturer and shall be a packaged type unit, fully shop assembled, wired and tested, requiring no field assembly of critical moving parts.

3. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, and motor sizes are appropriate; and that all devices necessary for properly functioning system have been provided.

4. Contractor shall, at his own expense, arrange for and obtain all necessary permits as required for the package, inspections, and approval by the proper authorities in local jurisdiction of such work.

5. Contractor shall properly coordinate the work between the suppliers of equipment to be used with or connected to engine-generator, including the switchgear furnished by others, to ensure that all required provisions for mounting the accessories are included.

6. Contractor shall provide field services specified to assist in commissioning, testing and placing the unit in operation in full conformity with equipment manufacturer's specifications.

E. Governing Standards.

1. Except where modified or supplemented by these specifications, all equipment and materials shall be designed and constructed in accordance with the latest applicable requirements of the standard specifications and codes of ANSI, ASTM, NEMA, IEEE, EEI, EGSA, HEI, ISO, NFPA, SAE, STI, UL and other such regularly published and accepted standards as well as state and local codes.

F. Tagging.

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

G. Power Supply.

1. Site power supply provided will be 208 V, 60 Hz three phase for operation of the equipment and accessories. The engine-generator shall be provided with a panelboard sized to power the required loads inside the enclosure as specified

herein. If required, a control transformer shall be provided within the panelboard for control supply.

2. The engine (starting and controls) will operate from batteries specified herein.

H. Identification.

1. Equipment shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS.

A. Drawings and Data.

1. Complete assembly and installation drawings, together with detailed specifications and data covering materials, drive unit, parts, devices and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittal Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Manufacturer, model, and type:
   1) Engine.
   2) Alternator.
   3) Enclosure.
   4) Battery charger and battery.
   5) Fuel oil cooler (if required by engine design).
   6) Silencer.
   7) Sub-base fuel storage tank

b. Engine output horsepower at rated capacity.
c. Fuel consumption at rated capacity.
d. Ratings at specified conditions:
   1) Engine (net horsepower).
   2) Generator kW at specified power factor.
   3) Volts.
   4) Amperes.

e. Overall dimensions and weight:
   1) Length.
   2) Width.
   3) Height.
   4) Net weight.

f. Wiring diagrams and schematics, including the engine control panel, all enclosure wiring, and generator line circuit breaker.
g. Alternator insulation class and temperature ratings.
h. Alternator winding pitch.

i. Confirmation or test results showing compliance with specified motor starting and voltage dip requirements as well as unloading the specified loads.
j. Generator line circuit breaker rating.
k. Control panel layout, identifying location, size and connection type for of all instrumentation being supplied.
l. Engine drawing to include location, size and connection type for all piping connections.
m. Drawing showing location of all electrical connections, including the grounding system.
n. Operation instructions.
o. Letter from the engine-generator manufacturer confirming that the unit will provide the specified minimum kW rating at the specified design conditions and time duration including ambient air temperature rise from all equipment located inside the enclosure.
p. Confirmation that the starting batteries provide the specified number of start attempts for the specified time period.
q. Confirmation that the battery charger is sized to recharge the batteries for the specified conditions and time period.
r. Maximum output short circuit kvA available.
s. Exhaust gas emission data, maximum value loads of 1/2, 3/4, and full:
    1) Carbon Monoxide (CO), lb/hr
    2) Nitrogen Oxides (NO_x), lb/hr
    3) Particulate Matter (PM), lb/hr
    4) Temperature, F
    5) Flow, acfm

t. Equipment skid drawing including material list.
u. Confirmation that the exhaust through the exhaust silencer does not exceed the specified maximum pressure loss at the nameplate capacity of the unit.
v. Letter from the engine-generator manufacturer confirming that the enclosure is suitable for the specified wind velocity and is designed as specified for rain penetration when the unit is operating.
w. Letter or certificate from the engine-generator manufacturer confirming that the unit is in full compliance with Federal EPA, State, and the local air emission requirements.
x. Confirmation that the engine-generator unit, including the enclosure, louvered openings, and exhaust system will limit the noise not to exceed the specified decibel reading at the specified distance from any point from the unit while operating the specified load.
y. Provide recommendation for mounting the engine-generator for the specified seismic parameters.
z. Anchor Bolts including quantity, location, and sized required.
aa. Name, address, and phone number of manufacturer's repair facility.
bb. Color chart showing available options for the enclosure color. The color of the enclosure shall be as directed by Owner during shop drawing review.
cc. Drawings showing engine-generator inside the enclosure that shows location of all enclosure mounted and engine-generator mounted equipment. Drawings to indicate maintenance access clearances for electrical and

mechanical equipment. Drawing to show location of all enclosures bracing and location of doors, sub-base tank fill access door, and removable panels.

dd. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

ee. Electric governor control

ff. Time current curves and setting for Generator Circuit breaker and Panelboard circuit breakers

B. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handing Requirements section.

1.5 SPARE PARTS.

A. The following spare parts and accessories shall be furnished in substantial wooden boxes with identifying labels and delivered to the Owner as directed:

Spare Parts	Quantity
Air filters.	2 sets
Oil filters.	4 sets
Fuel filters.	12 sets
Crank case filter media	1 set
V-belts.	1 set

B. If any of the above spare parts are used during the installation process, they shall be replaced by the Engine-Generator Supplier at no cost to the Owner.

C. All spare parts shall be provided in waterproof packages suitable for export service, labeled with its description and part numbers. Each item or set of parts expected to be installed at one time shall be in an individual package. The spare parts shall be stored as directed by the Owner.

D. Keys.

1. Three (3) sets of identical individual keys for locks on the enclosure and all cabinets shall be provided.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS.

A. The engine-generator unit shall be designed to operate under the following service conditions:

Seismic wind and snow design requirements including importance factor.	See Meteorological and Seismic Design Criteria Section	
Ambient air temperature range outside the enclosure.	-1 to 110	°F
Site elevation.	620	ft

B. The engine-generator unit shall be suitable for “black start” and will be used as a power unit for selected electrical loads when the utility supplied power fails.

C. Upon utility power failure, the engine-generator shall automatically start, and connect to the electrical loads when initiated from the automatic transfer switch.

D. The unit shall be furnished with all equipment required to allow it to operate alone .

E. Fuel for the engine-generator unit will be furnished from a sub-base fuel tank.

F. The Engine-Generator Supplier shall provide the correct amount and grade of crankcase oil, coolant, and other fluids (except fuel) necessary for initial testing and operation.

G. Engine Mounting.

1. The engine-generator shall be attached to an associated skid suitable for mounting on top of the sub-base fuel storage tank that is anchored to a reinforced concrete base. The skid shall be constructed of heavy-duty steel. It is designed and built to resist deflection and to maintain alignment during lifting and operation during any range of operation. Mounting holes in the structural skid shall be suitably sized to accommodate thermal expansion of the unit and shall be drilled prior to setting the unit in place.

2. Unless otherwise recommended by the manufacturer, the engine-generator sub-base fuel storage tank package shall be attached to the reinforced concrete base using a suitable number of hold down lugs and anchor bolts. Use of clamping devices to secure the sub-base fuel storage tank will not be acceptable. Anchor

bolts may be pre-cast in the reinforced concrete base or holes drilled into the concrete base at the required location and the anchor bolts secured with epoxy resin. Unless otherwise recommended by the manufacturer, the nuts for the anchor bolts shall be hand tighten.

H. Anchor Bolts.

1. Anchor bolts, nuts, and washers shall be stainless steel and comply with the Anchorage in Concrete and Masonry section. The Engine-Generator Supplier shall provide the design for the anchor bolt spacing, bolt size, embedment depth and anchor bolts. The Contractor shall be responsible for furnishing and installing the anchor bolts per the manufacturer's instructions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. The engine-generator unit shall be designed for the operating conditions and requirements as follows:

Designation	GEN-5000	
Generator		
Minimum power rating capacity with accessories, for generator voltage output and service conditions specified herein.	350 kW	
Output frequency.	60 Hz	
Output voltage.	480 VAC	
Output power factor.	0.8	
Output phase and configuration.	3-Phase	
Engine		
Fuel supply.		
Type	No. 2 Ultra-Low Sulfur Diesel	
Maximum speed.	1,800	rpm
Minimum piston displacement.	760	in^3
Maximum outside length of the engine-generator including air intake plenums and	20	ft

radiator discharge plenums but not including access platforms or stairs.		
Maximum outside width of the engine-generator package including air intake plenums but not including access platforms or stairs.	10	ft

B. The engine-generator unit shall be designed to be operated at varying loads, up to the specified power rating for the duration of a power outage plus a maximum of 50 hours per year for maintenance and testing. The engine-generator shall be certified for stationary emergency generator use in accordance with the Environmental Protection Agency (EPA) regulations.

C. Engine-generators submitted with ratings more than current published data will not be acceptable.

D. The entire engine-generator package system shall be electrically grounded.

E. Engine performance, cooling, and all accessories to account for the outside ambient air temperature increase from heat rejected from all the equipment located inside the enclosure.

F. The engine-generator unit furnished shall be of a design that can be accommodated in the space as indicated on the Drawings. Maximum outside dimensions of the engine-generator enclosure including any air intake or discharge plenums shall be, as specified and as noted on the Drawings.

G. The engine-generator shall be UL2200 listed and labeled.

H. The engine-generator shall meet the required Environmental Protection Agency New Source Performance Standard emission regulations, and any other local requirement. The unit shall be certified at the factory prior to shipping.

I. The Engine-Generator Supplier shall coordinate with the local air quality management authority to ensure the equipment meets all local air emission requirements. The Engine-Generator Supplier shall guarantee the equipment supplied meets all local air emission requirements at the time of startup. Field testing of actual emissions will be required as specified herein to verify compliance with the emission requirements.

J. The engine-generator shall, at minimum, meet the specified maximum allowable noise emission specified herein and any local noise emission requirements, whichever is more stringent.

K. Any special fittings or piping required for connection to fuel piping shall be furnished and installed.

2.3 Performance Requirements.

1. Loading Requirements.

a. The engine-generator shall satisfactorily start the following loads, while meeting the specified voltage dip.

*Step	Load Description	Load	Maximum Voltage Dip (%)	Comments
1	LTG TRANSFORMER 1	30	10	KVA
1	40-EF-0001	1	10	MOTOR
1	40-EUH-0005	2	10	KW
1	40-EUH-0001	3	10	KW
1	40-EUH-0002	3	10	KW
1	40-EUH-0003	3	10	KW
1	40-EUH-0004	3	10	KW
1	40-EUH-0008	3	10	KW
1	40-EUH-0009	3	10	KW
1	40-MAU-0001	2.4	10	KW
1	40-PPU-0001	1	10	MOTOR
1	40-EUH-0006	4	10	KW
1	40-EUH-0007	4	10	KW
2	Inlet Brush Aerator No.1	15	20	MOTOR
2	Inlet Brush Aerator No.2	15	20	MOTOR
2	Polishing Pond Brush Aerator	10	20	MOTOR
2	Ex Lift Station Pump 1	25	20	MOTOR
3	Inlet Brush Aerator No.3	15	20	MOTOR
3	Inlet Brush Aerator No.4	15	20	MOTOR
3	Ex Lift Station Pump 2	25	20	MOTOR
3	Ex Floating Brush Aerator No.1	15	20	MOTOR
3	Ex Floating Brush Aerator No.2	15	20	MOTOR

3	Future Inlet Pond Floating Brush Aerator No.5	15	20	MOTOR
3	Future Inlet Pond Floating Brush Aerator No.6	15	20	MOTOR

* The load steps in table here are indicative, Manufacturers/Supplier to do load sequencing for optimized generator sizing

2. Unloading Requirements.

a. The engine-generator shall satisfactorily unload the loads indicated above, in any order, one at a time, while not exceeding overspeed, frequency deviation, and voltage deviation.

2.4 ACCEPTABLE MANUFACTURERS.

A. Each engine-generator shall be a current production model. The engine-generator shall be manufactured by Caterpillar, Cummins, Rolls-Royce/MTU or Rehlko/Kohler.

B. The complete engine-generator package shall be assembled by the engine-generator manufacturer or their representative.

C. The manufacturer of the engine-generator unit shall have a full-time, fully factory trained technical staff and an equipped 24-hour service facility having all personnel and all equipment required to maintain, repair, or overhaul the engine-generator unit and associated equipment.

2.5 ENGINE-GENERATOR UNIT.

A. Engine.

1. The engine shall be a reciprocating 4-stroke cycle compression ignition, and shall be equipped with the following:

a. Electronic governor for isochronous regulation of engine speed from no load to full load alternator output.
b. Dry type air cleaner with replaceable elements.

B. Alternator.

1. The engine-generator alternator shall be a 4 pole, revolving field design with temperature compensated solid state voltage regulator, brushless rotating rectifier exciter system, and drip-proof construction with amortisseur windings. The alternator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semi-flexible driving flange to ensure permanent alignment.

2. Frequency regulation shall be isochronous ±0.15 Hz from no load to rated load. Voltage regulation shall be within ±2 percent of rated voltage, steady state, from no load to full load. The momentary voltage drop shall not exceed the specified percent without starter coils dropping out or stalling the engine at any time when applying or starting the specified loads. Recovery to stable operation shall occur within 2 seconds.

3. The alternator shall have Class F insulation as defined by NEMA MG1-1.65 and temperature rise shall be within NEMA MG1-32.6 definition at rated condition.

4. The winding pitch shall be 2/3 pitch

5. Harmonic filters shall be provided where determined by the Engine-Generator Supplier for proper operation when powering solid-state motor starters.

6. An alternator winding heater shall be furnished as an integral part of the engine-generator unit. Alternator winding heater shall be rated 120 volts, single-phase,. The alternator winding heater control system shall include an interlock with the engine-generator unit so that the heaters are always de-energized at all times the generator field is energized. The Supplier shall provide all internal alternator winding heater wiring and fused branch circuit protection.

7. Surge Protection.

    a. The engine-generator unit shall be provided with a voltage surge protection system installed in the generator terminal box or in a separate enclosure near the generator terminal box.
    b. The surge protection system shall include non-linear voltage-dependent metal oxide varistors (MOV) in parallel. All cables required to connect the surge protection system to the generator terminals shall be furnished and installed under this section.

C. Fuel System.

1. The engine-generator unit shall be furnished with a complete fuel system including engine-driven fuel pump, double wall sub-base fuel storage tank, engine supply and return lines, and all accessories required for proper operation. All items shall be suitable for the specified fuel and located inside the enclosure and serviceable from inside the enclosure. The engine driven fuel pump shall transfer the fuel from the sub-base fuel storage tank to the engine-generator.

2. The fuel system and all fuel piping shall be suitable for the specified fuel and shall meet all NFPA, State, and local requirements.

3. Sub-Base Fuel Storage Tank.

    a. The sub-base fuel storage tank shall be a rectangular sub-base type double wall fireguard type with dry type solid insulation between the two steel walls and shall be located below the engine-generator and shall be constructed to

permit access to the electrical stud-up area. The primary tank and secondary tank shall meet all EPA, state, and local requirements, be vented, and shall normally be used to store diesel fuel at atmospheric pressure. The primary internal steel tank and the secondary outer steel tank shall each be of welded construction throughout and each shall be built to UL standards.

b. The sub-base fuel storage tank shall be rectangular sub-base type, double-wall steel construction suitable for diesel fuel storage. The tanks shall be of welded construction throughout and shall provide integral secondary containment. The tank(s) shall be UL 142 listed and labeled for aboveground storage of flammable and combustible liquids and shall comply with NFPA 30 and NFPA 30A requirements. The tank shall be manufactured to and labeled in accordance with STI standards, no exposed concrete, spalling, or cracking with a minimum of five (5) year warranty.

c. The fuel storage tank shall have a minimum usable capacity to provide for 24 hours of continuous operation of the engine-generator when operating at 100 percent capacity, but not less than 650 gallons.

d. The secondary tank shall be closed top, encircle the tank, prevent the containment area from being contaminated, and sized to contain a minimum of 110 percent of the tank's capacity. All connections required for field-testing the secondary tank shall be furnished.

e. The fuel storage tank shall be provided with the following:
   1) Primary tank vent cap.
   2) Secondary tank vent cap.
   3) Primary tank emergency vent.
   4) Secondary tank emergency vent.
   5) Level gauge that can measure the fuel level without engine running and is viewable from the manual fill connection.
   6) Fill spill containment box.
   7) Automatic shutoff valve on the fill line.
   8) Check valve in the fill line.
   9) Cap for pump out connection.
   10) Quick Fill Coupling
   11) Immersion heater

4. Fuel Tank Connections.

   a. All connections for the sub-base fuel storage tank shall be located inside the enclosure and on top of the tank and shall include the following:
      1) Engine Fuel supply.
      2) Engine Fuel return.
      3) Primary tank vent.
      4) Secondary tank vent.
      5) Primary tank emergency vent.
      6) Secondary tank emergency vent.
      7) (Two, 2-inch diameter spare primary tank connections with caps.
      8) Secondary tank testing with cap.
      9) Leak detection.
      10) Manual fill.
      11) Pump Outlet.

12) Minimum 2 – inch tank manual pump out with cap. Pump out line to extend to within 2 inches of the bottom of the tank.
13) Minimum 3-inch diameter flange for tank connection with blind flange or suitable threaded cap.
14) Level gauge with transmitter for remote level indication on the engine control panel.
15) Low level switch.
16) High level switch with externally mounted alarm horn and silence button located near the fill connection.
17) High level switch if required for automatic shutoff of the fuel fill.
18) Tank Heater(s)
19) Low temperature switch
20) High temperature switch

5. Fuel Tank Instrumentation.

a. The fuel storage tank shall have instrumentation suitable for the geometric configuration of the tank that includes, but not limited to the following:
1) Level indication readout on the engine control panel with contacts for transmission of a remote 4-20 mA signal for remote level indication. Power, if required, shall be pre-wired and fed from the engine-generator local control panel.
2) Float switch with electrically isolated dry contacts for remote leak detection of the primary tank shall be provided with feedback to the engine-generator local control panel.
3) Low level switch (LSL) with electrically isolated dry contacts for remote low-level annunciation on the engine-generator control panel. The Low Fuel alarm shall be set to annunciate when 25 percent or less of the tank's capacity is remaining in the tank above the engine supply connection or when tank heater elements become exposed, whichever occurs first. Annunciation due to heating element exposure shall also de-energize the heater element, whichever comes first.
4) High level switch (LSH) for annunciating audible alarm at 90 percent capacity in the fuel storage tank. Audible alarm horn with silence button shall be located near the fill connection.
5) High-High level switch (LSHH) with electrically isolated contacts to shut off an electrically operated valve if used in the fill line at 95 percent capacity in the fuel storage tank.
6) One common, isolated, dry contact to close for any fuel system alarm.
7) Temperature switch for annunciating low fuel temperature on the engine control panel.
8) Temperature switch for annunciating high fuel temperature on the engine control panel and to de-energize the heater if the product reaches high temperature setting.

b. The fuel system controls shall be pre-wired and powered from the lighting panelboard.

6. Fuel Tank Fill Station.

    a. Tank fill connection, pump out, level gauge, and overfill alarm shall be accessible at ground level through a lockable access door in the enclosure. A fill spill containment box shall be provided for containment of spillage during tank fill or tank pump out.
    b. The fill system including piping, fittings, and the automatic shutoff valve, shall be suitable for a pump flow from a fill truck. The fill connection shall include a dry type quick disconnect coupling sized to accommodate the local fuel distributor.
    c. A ground stud for the fuel supply truck shall also be supplied.
    d. Tank fuel fill location shall be located as specified herein and as indicated on the Drawings.

7. Fuel Tank Overfill Protection System.

    a. A comprehensive fuel tank overfill protection system shall be provided as described herein. All devices and components shall be pre-wired from the system control panel with feedback to the Engine-Generator Control Panel as indicated.
    b. Set at 90 percent capacity, the High Fuel alarm shall provide an audible alarm near the fill connection to alert the fill operator to the percent overfill of the fuel storage tank. A silence push button shall be provided to silence the alarm horn, automatically resetting when the fuel tank level has dropped below the high level condition.
    c. The fuel storage tank fill line shall include a suitable means for automatic shutoff of the fill line when 95 percent of the tank capacity has been reached. If electric operated valve is used, it shall be AC powered and be interlocked with the High-High level switch. The fill system including piping, fittings, and the automatic shut off valve shall be suitable for a pumped flow from a fill truck.

8. Fuel Tank Vent System.

    a. A suitably sized vent connection and vent cover shall provide for the primary tank and secondary tank vent. Each vent cover shall be installed outside the enclosure. The cover shall have an aluminum body, screen over the outlet, and shall prevent rain from entering the vent line.
    b. Suitable sized emergency vent connections for the primary and secondary tank and emergency vents shall be provided for the fuel storage tank. Each emergency relief vent shall be installed outside the enclosure and shall be designed as required to relieve excessive internal pressure caused by fire exposure.
    c. Each vent line and each emergency relief vent line shall be routed up on the inside of the enclosure and shall terminate just above the enclosure.

9. Fuel Line Flexible Connections.

a. Stainless steel flexible connectors shall be provided for the diesel fuel supply and return lines and at a minimum shall be located at each connection to the engine, upstream of the combination fuel filter/separator, and in the return line to the sub-base fuel tank. The stainless-steel flexible connectors shall be U.S. Hose “Model 401M” or equal.

10. Fuel Filter.

a. A combination fuel filter/separator shall be located inside the enclosure and installed on the fuel supply line between the sub-base fuel storage tank and the engine driven fuel pump, upstream from the flexible connectors. The combination fuel filter/separator shall be a manifold unit with shutoff valves and shall permit servicing the filter/separator without engine shutdown. This shall permit valving off the filter/separator and bypassing the fuel to the other filter/separator. Filter separator shall be manufactured by Racor or equal.

11. Fuel Heater.

a. Electric resistance type immersion heater(s) shall be provided with the fuel storage tank. The heater(s) shall be suitable for the geometric configuration of the tank and shall be thermostatically controlled and sized to maintain the tank contents at 40 F at the specified winter ambient temperature.

12. Fuel Coolers.

a. Fuel oil coolers shall be provided if the engine fuel system absorbs heat from the unit injectors and surrounding jacket water. The fuel cooler shall be a radiator mounted, air cooled unit that uses the air flow from the radiator for cooling air flow. To prevent overheating of the fuel in the sub-base fuel storage tank, the fuel oil cooler shall be adequately sized to cool the return fuel from the engine to the required fuel inlet temperature.

D. Exhaust System.

1. The engine-generator unit shall be furnished with a complete exhaust system including an exhaust silencer, all exhaust piping, stainless steel bellows expansion joints, and accessories required for a complete operating system.

2. Exhaust piping shall be Schedule 10S, AISI Type 316L stainless steel with buttwelded fittings.

3. The silencer shall be all welded carbon steel construction. The exhaust silencer shall be furnished with suitable stainless-steel bracket supports for horizontal mounting either on top or inside the enclosure. The silencer shall be sized so that the back pressure at rated capacity of the engine does not exceed one half the manufacturer's maximum allowable back pressure. The exhaust from the engine shall enter either the top or side. The silencer manufactured by Maxim, Nelson, or equal.

4. The exhaust silencer shall be provided to meet the overall engine-generator unit noise emissions requirements specified herein.

5. The exhaust silencer, if located inside the enclosure, shall have all exhaust piping inside the enclosure be thermally and acoustically insulated with removable insulation.

6. If the exhaust pipe discharges vertically it shall discharge after the silencer outlet. A rain cap shall be provided to prevent rain from entering the exhaust pipe. The rain cap shall open from exhaust pressure from the engine and shall close when exhaust flow stops. The cap shall be stainless steel counter-balancing with vertical discharge.

E. Starting System and Control Power.

1. The engine-generator unit shall be furnished with a complete electric motor start system including starting motors, battery pack with rack, cables, and battery charger.

2. The batteries shall be of the high-rate, lead acid type and have a 24 volt output. The batteries shall be sized for five 10 second cranks with battery and engine oil temperature of 30°F, and a battery end voltage of 70 percent of system voltage.

3. The battery charger shall float-charge the battery pack and shall be solid state, full wave bridge rectified type, utilizing silicon-controlled rectifiers for power control.

4. The battery charger shall be suitable for the lead acid battery pack. The charger shall have a minimum DC output of 20 amperes. The battery charger shall be provided with a NEMA 2 corrosion resistant enclosure and shall be provided with the following: on/off switch, DC ammeter, DC voltmeter, AC input and DC output circuit breakers or fuses, floating voltage equalization, equalizing timer, and relays with form c contacts for remote annunciation of loss of AC power, low battery voltage, and high battery voltage.

5. The batteries, battery rack, and battery charger shall be located inside the engine-generator enclosure. The battery rack frame shall be constructed of battery acid corrosive resistant material. The battery charger and charging system components shall be supplied power from the panelboard specified herein and shall be wired by the Engine-Generator Supplier.

6. An engine driven alternator with an output voltage for the specified battery voltage shall be provided for battery charging during engine operation.

7. The engine-generator shall automatically supply power to the remote bus that powers the battery charger when it is operating and when utility power is not available.

8. An electric pad type heater shall be provided with the batteries. The pad heater shall be thermostatically controlled and be sized to maintain the batteries at 70°F

with a winter ambient temperature as specified. The pad heaters shall be powered from the panelboard specified herein and shall be wired by the Engine-Generator Supplier.

F. Cooling System.

1. The engine-generator unit shall be cooled with unit-mounted radiator cooling system complete with radiator, expansion tank, water pump, belt-driven fan, fan guard, thermostatic temperature control, high-water temperature cutout, electric jacket water heater and all accessories required for proper operation. The radiator shall be sized with sufficient capacity for cooling of the engine and all other accessories required for proper operation including the ambient air temperature rise inside the enclosure. The fan shall draw air over the engine and discharge through the radiator.

2. The cooling system shall be filled with a permanent antifreeze mixture of the ethylene glycol type with rust inhibitor suitable for the service conditions specified herein. suitable for six (6) years before coolant charge, Caterpillar, ELC, or equal.

3. The electric jacket water heater shall be furnished to maintain jacket water at 90°F with a winter ambient temperature as specified herein. The jacket water heater shall be thermostatically controlled.

4. The jacket water heater shall be powered from the panelboard supplied in this section and shall be wired by the Engine-Generator Supplier.

G. Engine-Generator Enclosure.

1. The engine-generator unit, including control panel, battery rack, battery charger, panelboard, sub-base fuel storage tank, and other ancillary equipment, shall be housed in a weatherproof and sound attenuated enclosure. The enclosure shall be shop mounted on the engine generator skid.

2. The enclosure shall be designed to withstand the specified conditions as defined in the Meteorological and Seismic Design Criteria Section.

3. The enclosure shall be as manufactured by Pritchard-Brown or equal.

4. Enclosure Fabrication.

   a. The enclosure shall consist of two side walls, and roof. The roof shall be braced as necessary to support the exhaust system. All bracing and reinforcing members shall be integral to the enclosure.
   b. Roof penetrations for the installation of the silencer shall be gasketed to prevent the entrance of rain.
   c. The enclosure shall be constructed of either (steel) or (aluminum).
   d. Steel enclosures shall be constructed with a support frame of not less than 14 gage steel and roof panels of 16 gage. Aluminum enclosure shall be formed sheet aluminum construction, made of modular panels and louvers.

Posts, rails, channels, and roof bows shall be 6061-T6 extruded aluminum. The panels shall be 0.040 inch thick minimum.

e. Access service platforms along each long side shall be provided if the bottom of the access doors into the enclosure height exceeds twenty-four (24) inches. Access platforms and stairs shall be of galvanized steel or aluminum construction. The access platforms shall be four (4) feet wide and shall be located on each side of the enclosure with individual stairs to each platform. Suitable brackets shall be welded to the enclosure at the factory for field-bolting the access platforms or stairs onto the brackets on the enclosure. Stairs and handrails shall not prevent the enclosure doors from opening fully.

f. The service platforms and stairs shall be OSHA compliant and shall be provided by the engine-generator manufacturer.

g. The enclosure shall be rain proof type as defined by UL2200 and shall prevent the wetting of live parts when the unit is operating. If required to meet the rain penetration requirements, “rain resistant” louvers, vertical air turning plenums or a combination of the two shall be provided.

h. The enclosure walls shall be reinforced to support the plenums. Plenums shall utilize bracing as required to prevent vibration and damage from the specified wind velocity in the Meteorological and Seismic Design Criteria Section, and shall bolt to the enclosure walls to permit removal and reinstallation.

i. A minimum of four separate doors, two per side, shall be provided and located for easy maintenance access to the engine-generator, controls, and accessories. Doors shall be lockable with stainless steel hardware. Width of each individual door shall not exceed three (3) feet.

j. The entire enclosure, except for the louvered openings, shall be provided with noise suppression insulation.

k. The enclosure shall be provided to meet the overall engine-generator unit noise emission requirements as specified herein.. Field sound level tests shall be performed on the unit as specified herein.

l. The sub-base fuel storage tank fill connection location shall be accessible through its own access door from the ground level located on the enclosure as indicated on the Drawings.

m. An access door shall be provided in front of the auxiliary power terminal box, control panel, and panelboard to permit access and working space from outside the enclosure when the door is open.

n. Engine oil and coolant drains shall be piped to the outside of the enclosure with lockable shutoff valves and caps.

o. All enclosure penetrations shall be gasketed or sealed to prevent the entry of rodents.

p. The enclosure shall be cleaned and painted as specified herein.

5. Enclosure Ventilation.

a. The enclosure shall be provided with intake and exhaust louvers with dampers to open on engine start. Louvers and dampers shall be sized for the cooling air requirements. Louvers shall be AC powered closed and spring open on unit start. The louvers shall be screened from the inside to prevent

the entry of birds. The louvers shall be pre-wired to the panelboard specified in this section.

b. The enclosure shall be provided with vertical air turning plenums for radiator discharge air. The radiator discharge plenum shall direct the air and mechanical noise upwards away from the unit, and shall be supplied with a bottom sump area, with a minimum one-inch size drain and shutoff valve to remove any moisture.

6. Electrical.

a. The engine-generator enclosure shall be provided with interior AC/DC operated maintenance lights, controlled with a 1 hour, wind-up, timer switch shall also be provided. A duplex receptible rated 20 amp,125 volts, with a weatherproof enclosure shall be mounted inside or near the middle of the enclosure.

b. A single 100A, 3PH, 208VAC shore power service will be provided by on site contractor. The enclosure shall be pre-wired, requiring only a single external 3 phase power connection to the panelboard. Panelboard shall have a main circuit breaker or the enclosure shall be provided with a single main circuit breaker for the control power.

H. Crankcase Vent Blow-By Absorber.

1. If a vertical radiator discharge is not provided, engine-generator manufacturer shall provide a suitable crankcase breather system to remove oil mist form the crankcase emission prior to induction in to the air intake system. The system provided shall meet the applicable level emission requirements.

I. Control Panel.

1. The engine-generator unit shall have a unit mounted control panel that shall be accessible from outside when the enclosure doors are open. The panel shall be provided with vibration isolators to prevent damage to the instruments from engine-generator vibration. Adequate clearance shall be provided between the panel and engine to allow engine maintenance without removing the control panel.

2. The control panel shall, at a minimum, include all items required by NFPA 110, Level 1. In addition, the control panel shall be provided with the following instrumentation and controls:

a. Tachometer.
b. Non-resettable hour meter.
c. AC voltmeter, AC ammeter, voltmeter/ammeter selector switch with “off” position.
d. Two normally open dry contacts which close when the engine is running and open when it is stopped.
e. Dry contact that closes for remote common alarm.
f. Dry contact that closes when the control selector switch is in “Auto”
g. Three-position selector switch with “RUN-OFF- AUTO”

h. Indicating lights with common alarm for the following:
   1) Sub-base tank with low fuel level.
   2) Sub-base tank leak detection.
   3) Sub-base tank low fuel temperature
   4) Sub-base tank high fuel temperature

i. Sub-base tank continuous reading level.
j. Dry contact for common fuel alarm.

3. Contacts for a remote two position maintain contact emergency shutdown switch.

4. The control panel shall be provided with a three-position selector switch with the following positions: “RUN-OFF-AUTO”. In the “RUN” position, the engine starting sequence shall be initiated providing local control for maintenance, in the “ AUTO” position, the engine-generator will be remotely started and stopped by a run contact from the ATS. Isolated contacts for when the unit is in the “OFF” position shall be provided for remote indication.

5. Emergency Shutdown Control Station.

   a. A remotely located emergency shutdown control station shall be furnished under this section and connected to the engine-generator control panel. The control station when activated shall shutdown the engine generator regardless of the position of the “RUN-OFF-AUTO” selector switch. The control station shall be located as indicated on the Drawings. Control wiring between the control station shall be wired in series with the emergency stop located on the engine-generator control panel and the engine-generator control panel shall be furnished by the installing Contractor.

J. Panelboard.

1. The engine-generator unit shall have an A 120/208 VAC panelboard with 3P rated main circuit breaker and branch circuit breakers that will power the required loads inside the enclosure as specified herein. The panelboard shall be mounted inside the enclosure and isolated from the engine-generator vibration. The power center panelboard shall be pre-wired to all engine-generator accessories as needed. The panelboard shall supply power including but not limited to the following:

   a. Engine-generator starting system battery charger.
   b. Enclosure lights and receptacles.
   c. Fuel system.
   d. Enclosure intake and exhaust louvers/dampers.
   e. Engine jacket water heater.
   f. Alternator winding heater
   g. Battery strip heater for starting batteries

2. The panelboard shall have an internal surge protection device as specified in the Electrical section. All electrical equipment and materials shall meet the applicable requirements of the Electrical section.

K. Generator Line and Generator Component Overcurrent Protection.

1. Generator line circuit breaker rated for the generator output voltage, having the trip rating indicated on the Drawings, shall be provided on the output terminals.

2. The line circuit breaker shall be pre-wired to the generator output terminals and shall be provided within the generator enclosure in outdoor applications or shall be furnished in a skid mounted NEMA 1 enclosure for indoor applications.

3. Overcurrent protection devices shall be provided as needed by the system design to protect generator rotor and excitation system components.

L. Limiting Dimensions.

1. The engine-generator unit furnished shall be of a design that can be accommodated in the space available as specified herein.

M. Noise Emissions.

1. The engine-generator Units, including the enclosure, louvered openings, and exhaust system, shall be designed to limit the noise emissions to not exceed the A-weighted sound pressure level of 75 dB(A) at 23 feet from any point the engine-generator unit when operating all the loads as specified during the performance test., and when measured in accordance with industry standards such as but not limited to ANSI S12.18, ASME PTC 36, ISO 8528-10.

2.6 SHOP PAINTING.

A. Engine-Generator.

1. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, engine, alternator, enclosure, piping, and valves shall be shop primed and finish painted prior to shipment to the site.

2. Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

3. Each engine generator system will be exposed to an atmosphere containing hydrogen sulfide and shall be protected against the corrosive effects of that atmosphere.

B. Enclosure.

1. The enclosure shall be thoroughly cleaned after assembly, etched, and shop painted, both interior and exterior surfaces. The enclosure shall be painted according to the manufacturer's standard practices with the interior receiving at least one coat of ANSI Gray. Exterior paint colors shall be as selected by the Owner.

2. All paint used for intermediate and finish coats shall be guaranteed by the paint manufacturer to be fumeproof and suitable for sewage plant atmosphere containing hydrogen sulfide. Any paint that cannot be so guaranteed shall not be used.

C. Sub-Base Tank.

1. The sub-base tank shall be thoroughly cleaned after assembly, etched, and shop painted. The sub-base tank shall be painted according to the manufacturer standard practices and coated with UV inhibitor. Paint color shall match enclosure color.

2.7 SHOP TESTS.

A. Engine-Generator Shop Test.

1. The manufacturer shall shop test the engine-generator set with its control panel and unit mounted radiator to demonstrate that the equipment conforms to nameplate requirements for load capacity using a load bank at the specified frequency, voltage, phase, and power factor.

2. All items included on the control panel shall be assembled, wired, and tested in the manufacturer's shop.

3. At a minimum, tests shall consist of repeated starts and stops, operation under a load bank at nameplate capacity, frequency, voltage, phase, and power factor for a minimum of 1 continuous hour, and tests to demonstrate that each safety shutdown device is working properly.

4. Contractor shall submit certified copies of the shop test results date of manufacturer and serial numbers of engine and alternator prior to shipping the unit.

B. Fuel Storage Tank Shop Test.

1. The manufacturer shall test the sub-base fuel storage tank using the tank manufacturer's procedures.

2.8 OPERATION INSTRUCTION.

A. Step-by-step instructions shall be furnished by the engine manufacturer for the unit. The instructions shall include, but not be limited to, the following procedures or information:

1. Startup of the unit.

2. Normal shutdown of the unit.

3. Emergency shutdown of the unit.

4. Normal operation of the unit, typical temperatures, pressures, speed, etc., for gauges and instruments which are displayed on the panel.

B. The operation instructions shall be submitted for review in accordance with the Submittals Procedures section. When the review is complete, the instruction sheets shall be printed on heavy paper or cardboard stock and laminated with clear plastic. Two copies of the laminated instructions shall be furnished with the unit. One copy shall be located or displayed at the control panel for the unit. The reserve copy shall be delivered to Owner. The instructions specified here are in addition to the operation and maintenance manuals required by the Submittals Procedures section.

2.9 PERMITS.

A. Engine-Generator.

1. Contractor shall be responsible for preparing and submitting air emissions permit application on behalf of the Owner to the local air quality authority for the engine-generator being supplied based on the maximum number of operating hours and the guaranteed emissions.

2. The permit shall include provisions for the Owner to contact the local air quality authority to operate the unit in the event the permit hours may be exceeded due to unforeseen emergency conditions.

B. Fuel Storage Tank Permits.

1. The Contractor shall be responsible for providing all plans, applications, and information needed for and applying and obtaining approval of the proposed construction and installation of the storage tank and fuel system as required by all local and state regulations.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. The engine-generator shall be installed in accordance with the Equipment Installation section and as specified herein.

B. The exposed finish shall be inspected after completing system installation, including pipe connections, fittings, valves, and specialties. Burrs, dirt, and construction debris shall be removed and any damaged finishes, including chips, scratches, and abrasions shall be repaired.

3.2 FIELD QUALITY CONTROL.

A. Installation Check.

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

3.3 FIELD TESTING.

A. Manufacturer's field services shall be provided for field testing. All costs for these services shall be included in the contract price.

B. Engine-Generator Performance Test.

1. The engine-generator unit shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition.

2. The engine-generator set shall be tested to demonstrate that the equipment conforms to specified requirements for load capacity and starting duty.

3. The complete system (engine, generator, exhaust system, starting system, fuel system, fuel, sub-base fuel storage tank, and control panel) shall be field tested together by the manufacturer as a complete system to assure compatibility.

4. The tests shall consist of repeated starts and stops, operation under a load bank at the nameplate power rating and power factor for the duration indicated below.

5. Before each of the following tests, the engine shall be brought to steady state conditions as determined by the instrument reading.

    a. The unit shall be individually testing for four (4) continuous hours at the nameplate rating and power factor within normal operating conditions of the unit without any alarm conditions.
    b. The unit shall demonstrate four (4) starts of the specified electric loads in order listed followed by 30 minutes of continuous operation per start within normal operating conditions of the unit without any alarm conditions.
    c. Demonstration that each safety shutdown device is working properly on the unit.

6. Supplier shall furnish the lubricants, load bank, and the fuel for the tests.

7. Any retesting or modifications to the equipment to meet the above requirements shall be approved by the Engineer. All costs of modifications and retesting, , shall be at no cost to the Owner.

8. The following items shall be measured, recorded at 15 minute intervals, and submitted in a field test report:

    a. Outdoor ambient temperature.
    b. Barometric pressure.
    c. kW output.
    d. Engine speed, rpm.
    e. Engine jacket water temperature.
    f. Engine oil pressure.
    g. Start time.
    h. Completion time.

9. Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

C. Field Sound Level Test.

1. The installed equipment shall be tested for noise during one of the 30 minute performance tests. The measured engine-generator sound levels shall not exceed the sound level specified herein.

2. Compliance with the noise emissions requirement shall be determined in accordance with industry standards including ASME PTC-36. Compliance shall

be based on not exceeding the allowable sound pressure level including background sound level corrections per Section 4-2.6 of ASME PTC-36 and excluding any correction for measurement uncertainties.

3. Any retesting or modifications to the equipment or enclosure to meet the above requirements shall be approved by the Engineer. All costs of modifications and retesting shall be at no cost to the Owner.

4. Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

D. Sub-Base Tank Field Test.

1. After shipment to the Site, but prior to installation, the inner primary tank and secondary outer tank shall be pressure tested. While maintaining pressure required by the tank manufacturer for the primary and secondary tank, the inner primary tank and the outer secondary tank shall be checked for leaks using an air gauge. During testing, connection may be plugged but shall not be blocked or plugged on the inside. If there are leaks or indications of leaks, the tank shall be replaced with a new tank and tested after shipment to the jobsite.

3.4 TRAINING.

A. The manufacturer shall conduct on-site training to instruct the Owner on operation and maintenance of the unit. The training shall be arranged and coordinated with the Owner through the Contractor.

B. The training program shall consist of two (2) identical sessions of four (4) hours each to be conducted on separate days for a class size of up to eight (8) per each session. For each training session, approximately half the time should be spent in a classroom environment and the other half in a hands-on environment.

C. A detailed outline of the material to be covered during each training session and training materials are to be submitted to the Engineer at least one month before the start of training for review, comment, and approval. The equipment representative shall provide an adequate number of printed trainee materials for all persons being trained. All costs for these services shall be included in the contract price.

3.5 INITIAL TANK FILL.

A. Upon satisfactory completion of all work, the contractor shall fill the sub-base fuel storage tank with the specified fuel.

End of Section

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SECTION 26 36 26 - BYPASS-ISOLATION AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 SCOPE

A. This section covers both indoor and outdoor automatic transfer switches which shall be furnished, and tested as specified and as indicated on the Drawings.

B. Automatic transfer switch equipment shall meet the design conditions and features.

C. Automatic transfer switch equipment shall be designated and located as follows:

Tag number(s).	FUE-ATS-5000
Transfer switch designation(s).	*ATS-WWTP*
Location of transfer switch(es).	*Chemical Building*

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected , and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If stipulations in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

E. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

F. Governing Standards

1. The equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

   a. UL 1008;
   b. NFPA 110;

2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

3. The automatic transfer switch shall be UL listed for use in standby power systems in accordance with Article 702, Optional Standby Systems, of the National Electrical Code.

G. Nameplates

1. Nameplates with designation of each control or indicating device shall be mounted on the switch enclosure. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch high letters for section identity and 1/8 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

H. System Characteristics

1. The equipment will be connected to a power system with characteristics as specified below:

Voltage, phase	480, 3-phase**]** V
Frequency	**[**60**]** Hz
Number of conductors	**[**3-wire**]**

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transfer switch, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

2. Drawings showing front and side views, plan, and weight.

3. Rating and specifications.

4. Circuit breaker time-current characteristic curves, if applicable.

5. Single-line, control schematic, and wiring connection diagrams.

6. Operation and maintenance and manuals including a list of spare parts.

7. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 SPARE PARTS

A. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed. Spare parts shall be provided as follows:

Spare Parts	Quantity

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The automatic transfer switch shall be a product of a manufacturer who has supplied such equipment for at least 5 years.

B. The automatic transfer switch shall be manufactured by Eaton, Schneider Electric,ABB(Zenith Controls), or Siemens, without exception.

2.2 CONSTRUCTION FEATURES

A. Enclosure

1. The enclosure for the transfer switch shall be as follows:

Type of mounting	**[**Freestanding**]**
Enclosure rating	**[**Indoor NEMA Type 1**]**

2. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

B. Rating

1. Automatic transfer switches shall be rated for continuous duty in both normal and emergency positions. The switches shall have the number of poles as specified below, and shall be double-throw. Ampere ratings, and 3-cycle closing and withstand ratings shall be as specified below.

Number of poles	**[**3-pole**]**
Ampere rating and 3-cycle closing and withstand rating	**][400/50,000**___ A**]**

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment Description

1. The automatic transfer switches shall transfer electric loads from the normal source of electric power to an emergency source of power as indicated on the Drawings. The transfer switches shall automatically transfer the electrical load circuits upon an interruption or a decrease in the voltage of the normal source of power and shall transfer the loads back to the normal source when it becomes available. The transfer switches shall be furnished without integral overcurrent protection. The switches shall be electrically operated but mechanically held in both the normal and emergency positions. The operating mechanism shall be momentarily energized from the source to which the load is being transferred. All main and arcing contacts and control elements shall be removable from the front of the switches without removing the switch from the enclosure and without removing the power cables. The automatic transfer switches shall be so designed that the load circuits cannot be connected to more than one source of power at a time. The automatic transfer switches shall be magnetic contactor type.

2. Automatic Transfer Switch

a. The automatic transfer switch shall be an electrically operated double throw switch. Main contacts shall be silver composition. Main and arcing contacts shall

be visible without major disassembly to facilitate inspection and maintenance. A manual handle shall be provided for maintenance.

b. Switches composed of molded case breakers, contactors, or similar components not specifically designed for automatic transfer switch applications will not be acceptable.

B. Control System

1. The control system shall consist of all control devices necessary to operate the switch as described. The system shall incorporate a microprocessor control module connected to the power transfer components by a wire harness and keyed disconnect plugs. The control module shall be completely enclosed with a protective cover and shall be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on plug-in circuit boards. All interface relays shall be identical and shall be control grade, plug-in type, with dust covers.

2. All control components shall meet or exceed the voltage withstand capability in accordance with IEEE C37.90.1 and NEMA ICS 1.

3. Performance

a. The automatic transfer switch shall be designed to function in accordance with the following requirements:

1) The voltage of each phase of the normal source shall be monitored and the pickup voltage shall be adjustable from 85 percent to 100 percent of nominal, and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pickup value. The transfer to emergency will be initiated upon reduction of the normal source to 85 percent of the normal voltage, and retransfer to normal shall occur when the normal source restores to 90 percent of the normal voltage.

2) A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals shall be provided. The time delay shall be field adjustable from 0.5 to 6 seconds and shall be factory set at 1 second.

3) A time delay to retransfer to the normal source shall be provided. The time delay shall be automatically bypassed if the emergency source fails and the normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.

4) An in-phase monitor shall be provided to control transfer so motor load inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and shall permit transfer only at acceptable values of voltage, phase relationship, and frequency differential.

5) An unloaded running time delay for engine-generator cool-down shall be provided. The time delay shall be field adjustable from 0 to 60 minutes and shall be factory set at 5 minutes.

4. Indication

a. The automatic transfer switch shall include indication features in accordance with the following requirements:
   1) A detailed step-by-step operating instruction plate shall be provided on the front of the switch.
   2) Indicating lights or microprocessor control display indication shall be provided for, but shall not be limited to, the following:
      a) Normal source available.
      b) Emergency source available.
      c) Automatic transfer switch isolated.
      d) Automatic transfer switch inhibit.
      e) Automatic transfer switch in normal position.
      f) Automatic transfer switch in emergency position.
      g) Automatic transfer switch in test mode.
   3) One auxiliary contact shall be provided that is closed when the automatic transfer switch is connected to the normal source and one contact that is closed when the automatic transfer switch is connected to the emergency source.
   4) A contact, which will close when the normal source fails, shall be provided to initiate engine starting. The contact shall be rated 10 amperes, 32 VDC and shall be gold plated for low voltage service.

C. Shop Painting

1. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, shall not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

D. Shop Tests

1. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and for compliance with the governing standards. Certified test results shall be submitted to Engineer before the equipment is shipped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The transfer switch will be installed in accordance with Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An installation check by a representative of the manufacturer is not required.

3.3 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

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SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing the design of lightning protection systems and the furnishing and installation of lightning protection equipment for the following structures:

1. New Buildings:

    a. Chemical Building

2. Existing Buildings:

    a. Cooling Water Pump Station
    b. Water Meter Vault
    c. Cooling Water Pump Station Electrical Building

B. Lightning protection systems shall be furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.

C. Lightning protection systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required to complete the system.

D. The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

1.2 GENERAL

A. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor and obtain all inspections to complete the work as specified, and in compliance with all codes, standards, and regulations.

B. Contractor shall provide coordination with other contractors and supervision of installation as needed during construction.

C. The design of the system shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime.

D. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of UL unless exceptions are noted by Engineer.

E. The system shall be installed by an installer who has UL listing and subscribes to the UL Follow-Up Service.

F. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

G. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

H. Governing Standards

1. All system components furnished under this section shall be designed in accordance with ANSI/UL 96 - Lightning Protection Components. All lightning protection systems furnished under this section shall be designed, constructed, and tested in accordance with UL 96A – Installation Requirements for Lightning Protection Systems and ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems.

2. Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.

I. Workmanship and Materials

1. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, unless required by tests.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the Submittals Procedures section.

B. Meteorological and Seismic Design Criteria Compliance

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 QUALITY ASSURANCE

A. The lightning protection system shall be inspected and tested after installation by conducting continuity and ground resistance tests as well as a visual inspection. Inspection results and test data shall be submitted in accordance with the Submittals Procedures section. Upon completion of the installation, Contractor shall apply for and deliver the UL Master Label Certificate of Inspection for each structure/building.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2.2 MATERIALS

A. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:

Conductors	Copper.
Air Terminals	Copper or bronze.
Grounding Electrodes	Copper clad steel.
Fasteners	Copper or bronze.
Bimetallic Fasteners	Bronze and aluminum.

B. Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.

C. All materials furnished for the lightning protection system shall bear the inspection label of UL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

B. Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

C. The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

End of Section

SECTION 28 31 19 - FIRE PROTECTION AND SIGNALING SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section covers **[**the design of a fire protection and signaling system and **]**the furnishing and installation of a fire protection and signaling system. All associated equipment, devices, and controls necessary for proper operation shall be included.

B. The design of the system shall consist of, but shall not be limited to, a determination of the applicable fire and safety codes; an analysis of the various plant ambient temperatures, noise levels and environments (wet, dusty, oily, corrosive, hazardous, etc.); the number and type of detectors, alarm indicators, and manual stations required; and the proper wiring and mounting configurations.

C. Peripheral components as specified shall be located as indicated on the Drawings and provided in sufficient number and located as needed to meet all applicable codes.

D. The signaling system supplier shall coordinate with the fire suppression system supplier for monitoring of sprinkler system flow switches, anti-tampering switches, and other associated devices.

E. The fire protection and signaling system includes a single fire protection and signaling panel (FACP-4000) located in the Electrical Room within the Chemical Building.

1.2 GENERAL

A. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor to complete the work as specified, and in compliance with the codes, standards, and regulations listed below.

B. Contractor’s Qualifications

1. The system design, equipment, installation, and installation supervision furnished under this section shall be provided by a single manufacturer or supplier who has been engaged in the business of supplying fire alarm systems of this type for at least 5 years.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. AL State Fire Marshal's Regulations for Safety to Life from Fire and Emergencies in Buildings and Structures, and General Fire Protection.

2. National Fire Protection Association, NFPA 45*,* 71, 72, 90A, and 101.

3. City of Bridgeport Fire Department Regulations

4. National Electrical Code, Article 760.

F. All fire alarm equipment and materials, devices, and assemblies shall be listed and/or labeled by Underwriters' Laboratories, Factory Mutual, or another accepted testing laboratory for the intended purpose where acceptable to the authority having jurisdiction. The equipment shall not be altered, installed, or modified in any way that would void the label or listing.

G. All control equipment shall have transient voltage protection devices in compliance with UL 864.

H. The system controls shall be UL listed for Power Limited Applications according to NEC 760. All circuits shall be marked in accordance with NEC 760-10.

I. Nameplates

1. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item.

J. Tags

1. Keys and locks shall be furnished with tags bearing stamped identification numbers. Cable and conduit runs, wiring circuits, and all spare parts supplied to maintain the system shall be furnished with hard phenolic or stainless steel tags.

K. Power Requirements

1. Power supply to the fire protection signaling panel (FACP) will be 120 volts, 60 Hz, single phase.

2. The alarm system shall include an automatically recharged backup power supply with sufficient battery capacity to operate the entire system in the normal supervisory mode for 24 hours and then sound all alarms for 5 minutes. In the event of power failure, the system shall automatically transfer to the standby batteries.

3. All external circuits requiring system-operating power shall be suitable for 24 volt dc service and shall be individually fused at the control panel.

L. Spare Parts

1. Spare parts as specified below shall be supplied with the fire protection and signaling system. Spare parts shall be suitably packaged for shipment.

Spare Parts	Quantity
Audiovisual alarms	One of each type used

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete electrical wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the Submittal Procedures section.

B. Agency Review Package.

1. In addition to the submittals to Engineer, Contractor shall submit complete plans and information to the local fire department for review. Contractor shall provide signed and sealed plans by a registered engineer in the state of where required by local or state requirements. The equipment submittals shall include the following:

a. A complete description of all system components, including certification of listing by the required testing laboratory.
b. Complete sequence of operation for all functions of the system.
c. Complete system wiring diagram for all components and interfaces to equipment supplied under other sections.
d. Location drawings for all controls, alarm actuating devices, and audiovisual alarm signaling devices.
e. A listing of the manufacturer’s representatives responsible for installation and service.
f. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
g. Operation and maintenance manuals.

1.4 SYSTEM DESCRIPTION

1. The fire protection and signaling system shall be operated and monitored by **[**a fire protection and signaling control panel (FACP), located in the Chemical Facility electrical room**]**. The system shall automatically initiate fire alarm signals whenever any manual or automatic fire detection device is placed in an alarm mode. The system shall transmit a signal to the plant control system. The FACP shall annunciate and sound local alarms for detection device alarm conditions, system trouble, or circuit failure. Alarm signals shall be consistent throughout the building. The operation of any alarm initiating device shall cause audible and visual alarms to sound and to be displayed throughout the building as

required by applicable codes. A key-accessible reset function shall reset the alarm system after alarm initiating conditions have been cleared.

2. The system functions shall include area detection, manual stations and sprinkler system monitoring.

3. The system shall automatically activate smoke detected audiovisual annunciation equipment whenever an area smoke detector or duct smoke detector is in alarm mode. The system shall identify the device and the location.

B. System Configuration

1. Initiating device, notification device, and signaling line circuits shall be NFPA 72, 3-4, Class A. The system shall monitor incoming power and standby power. In addition to the FACP, the system shall include heat detectors, smoke detectors, audiovisual alarm units, end-of-line devices, manual pull stations wiring connections to devices, outlet boxes, junction boxes, and all other necessary equipment for a complete operating system.

2. System trouble, including grounded or open supervised circuit, power failure, system battery low voltage, or system failure, shall cause the system to enter a trouble mode and display visual and audible alarms. The visual alarm shall be displayed until the initiating trouble has been cleared.

3. Fire Alarm Activation Sequence

a. The alarm sequence initiated by the activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
   1) Audible alarm indicating devices within the room or facility served by the detection equipment or ventilation ducts shall sound a march time code until silenced by the alarm silence switch at the FACP.
   2) Visual alarm indicating devices within the room or facility served by the detection equipment or ventilation ducts shall display a continuous strobe pattern until the system is reset.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All panels and peripheral devices shall be the standard products of a single manufacturer, and the manufacturer's name shall be displayed on each component. The system shall be manufactured by Bosch Security Systems; Gamewell-FCI; Notifier; Siemens Building Technologies; or Simplex Grinnell.

2.2 REMOTE SENSORS

A. Fire Alarm Pull Stations

1. Addressable pull stations shall communicate the station's status (alarm, normal) over two wires that also supply power to the pull station. The address shall be set on each station. The stations shall be manufactured from high-impact red Lexan. Lettering shall be raised and painted white. When activated, the stations shall mechanically latch and remain latched until they are manually reset using a key common to all locks.

2. The location "address" of the pull stations shall be capable of field programming from the FACP over the signaling line circuit.

B. Smoke Detectors

1. Analog addressable smoke detectors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel. The sensors shall be solid-state, containing no radioactive material, and shall be capable of detecting up to seven sensitivity levels between 0.5 and 3.7 percent.

2. The sensors shall be plug-in units mounted on a twist-lock base. Smoke detector bases shall be common with the heat detector bases and shall be compatible with other addressable detectors and addressable manual stations on the same circuit. The detectors shall be suitable for both ceiling and wall mounting and shall have a 30-mesh insect screen. Detector bases shall contain a light emitting diode that will flash each time it is scanned by the control panel. When the sensor detects smoke or fails, the diode shall illuminate to indicate the abnormal condition. When required, detector bases shall be provided with a relay driver output that may be controlled either automatically or manually from the control panel.

3. Each detector shall contain a magnetically actuated test switch for alarm testing at the sensor location.

4. Smoke detectors for installation in ducts shall be as specified above and shall be provided with auxiliary dpdt relays, remote LED alarm indicators, and key-operated test stations.

C. Heat Detectors

1. Addressable heat detectors shall be ambient compensated combination rate-of-rise and fixed temperature types. The fixed temperature operation of the sensor shall be selectable for either 117° or 135° F . Rate-of-rise operation shall be selectable for either 15° or 20° F per minute and shall be self-restorable.

2. The thermal type sensor shall be a plug-in unit that mounts on a twist-lock base. Bases shall be as described for smoke detectors.

D. Audiovisual Alarm Units

1. Alarm units shall consist of a horn and a Xenon flashtube installed in a surface or semi-flush wall- or ceiling-mounted enclosure. The horn shall have polarized connections with separate leads for in/out wiring for each leg of the associated signal circuit. Sound level shall be 90 dB at 10 feet .

2. The visual unit shall operate on 24 volts dc and shall have a white translucent pyramidal lens with the word “FIRE” imprinted in red lettering for fire alarm circuits. The flash rate shall be 1 to 1.5 times per second.

E. Auxiliary Relays

1. Auxiliary relays shall be supplied where required. The relays shall be of high quality and shall be fitted with dusttight plastic covers. The contacts shall be at least 1/8 inch in diameter, of gold-plated silver cadmium oxide, rated for 5 amperes at 115 volts ac.

F. Addressable Input Modules

1. Each external dry contact input from sprinkler system flow switches, and other required auxiliary inputs shall be equipped with addressable input modules designed to provide circuit monitoring and point identification of dry contact inputs.

2.3 PANELS

A. Fire Protection and Signaling Control Panel

1. The control panel shall be an analog/addressable type supervised alarm control panel. The panel enclosure shall be constructed from steel, in compliance with UL 864, with front access door, and shall be surface wall-mounted.

2. The control panel shall be of modular construction, with solid-state, microprocessor-based electronics, and shall display only the primary controls and functions essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during alarm, trouble, or supervisory conditions. The sound that identifies each condition shall be readily distinguishable without having to view the panel. The audible device shall also sound during each key press to indicate that the key has been pressed. The panel shall be fully field programmable from the keypad and capable of downloadable programming from a Windows-based application program. The panel shall include self programming logic capable of automatically programming new addressable field initiating devices.

3. The following primary controls shall be visible through a front access panel:

a. Eighty-character liquid crystal display.
b. Red system alarm LED.
c. Yellow supervisory service LED.
d. Yellow trouble LED.
e. Green “power on” LED.
f. Alarm acknowledge key.
g. Supervisory acknowledge key.
h. Trouble acknowledge key.
i. Alarm system key.
j. System reset key.
k. Manual evacuation (drill).

4. The control panel shall include the following functions:

    a. Setting of time and date.
    b. LED testing.
    c. Listing of alarm, trouble, and abnormal conditions.
    d. Separate enabling and disabling of each monitor point.
    e. Separate activation and deactivation of each control point.
    f. Changing operator access levels.
    g. Walk-test enable.
    h. Running diagnostic functions.
    i. Displaying software revision level.
    j. Displaying historical logs.
    k. Displaying card status.
    l. Point listing.

5. The following lists from the points list menu shall be available for maintenance purposes:

    a. All points by address.
    b. Monitor points.
    c. Auxiliary controls.
    d. Feedback points.
    e. Pseudo points.
    f. LED/switch status.

6. Scrolling through menu options or lists shall proceed in a self-directing manner, guided by prompting messages. The controls for the points list menu shall be located behind an access door.

7. The control panel shall contain a back lighted 2 line by 40 character liquid crystal display. To conserve standby battery power in the event of an ac power failure, the display shall be lit only during keypad activity.

8. The display shall consist of both upper case and lower case letters. Lower case letters shall be used for soft key titles and for prompting the user. Upper case letters shall be used for system status information. A cursor shall be visible when information is being entered.

9. All wiring shall be brought to terminal strips for field connections.

10. Front Panel Operation and Capabilities

    a. Under normal conditions, the front panel shall display a “SYSTEM IS NORMAL” message and the current time and date.
    b. Should an abnormal condition be detected, the appropriate alarm, supervisory, or trouble LED shall flash. The audible signal shall pulse for alarm conditions and sound steady for trouble or supervisory conditions.
    c. The LCD shall display the following information pertaining to the abnormal condition:
        1) Location label (40 characters available).

2) Type of alarm device - smoke detector, pull station, gas detection, ventilation failure, and water flow sensor.
3) Point status - alarm, trouble.

d. Buttons shall be provided to acknowledge alarm conditions and to silence audible alarms in compliance with NFPA 72.

11. Alarm Silencing

a. When the “ALARM SILENCE” button is pressed, all alarm signals shall cease. Alarm signals shall not be silenced during “alarm silence inhibit” mode.

12. System Reset

a. Using the “SYSTEM RESET” button shall restore the system to its normal state after an alarm condition has been remedied.
b. The LCD display shall step the user through the resetting procedure with simple printed messages.

13. Device Status

a. Complete status of all addressable field devices shall be available through use of the operator keypad and front panel display.

14. History Logging

a. The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery-protected random access memory. Each recorded event shall include the time and date of the occurrence.

15. Silent Walk Test with History Logging

a. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. After logging the alarm, the panel shall automatically reset.
b. The momentary disconnection of an initiating or indicating device circuit shall be silently logged in the historical data file as a trouble condition. After logging the trouble condition, the panel shall automatically reset.
c. Should the walk test feature be on for an inappropriate length of time, it shall automatically revert to the normal mode.
d. The control panel shall be capable of supporting up to eight separate testing groups, one of which may be in a testing mode while the other (nontesting) groups may be active and operating as normally programmed. After testing is completed, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.
e. Should an alarm condition occur from an active point that is not in walk test mode; it shall initiate the normal alarm sequence.

16. LED Supervision

    a. All LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the location numbers of the module and the LED to facilitate location of the affected LED.

17. System Trouble Reminder

    a. In the event of a trouble condition within the system, with the audible signal silenced, the trouble signal shall resound at 24 hour intervals as a reminder that the fire protection and signaling system is not 100 percent operational. Both the time interval and the trouble reminder signal shall be programmable to adapt to the application.

18. Operator Access Levels

    a. Operator access to system functions shall be limited by a key switch and multiple levels of password protection.
    b. The following functions shall be protected:
        1) Alarm Silence.
        2) System Reset.
        3) Set Time/Date.
        4) Manual Control.
        5) On/Off/Auto Control.
        6) Disable/Enable.
        7) Clear Historical Alarm Log.
        8) Clear Historical Trouble Log.
        9) Walk Test.
        10) Change Alarm Verification.

    c. Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an acknowledge key with insufficient access, an error message will be displayed. The points shall scroll with acknowledge key presses to view the points on the list, but the points will not be acknowledged in the database.

19. Wiring

    a. Intermodule wiring for common system functions shall be installed in a supervised cable bus. Disarrangement of the bus shall cause a distinctive “Cable Supervisory” LED to be illuminated in addition to activating the common trouble indicators.
    b. Detector and signal circuits and wiring may be nonpower-limited type and shall comply with the applicable articles of the NEC.

B. Enclosures

1. A cabinet of sufficient size shall be provided to accommodate all equipment required. The door of the cabinet shall be equipped with locks and a continuous hinge, providing protection from tampering, yet allowing full view of the various lights and controls. Indoor enclosures shall be of a NEMA type suitable for the area designation.

2.4 CABLE AND RACEWAYS.

A. Cable

1. Cable used in the fire protection and signaling system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial fire protection and signaling systems and UL listed for indoor/outdoor installations. All cable required for the system shall be furnished by the Contractor.

B. Raceways

1. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of the Electrical section.

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall be installed as indicated on the Drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

B. All junction boxes furnished hereunder shall be painted red and permanently labeled "FIRE ALARM." A consistent wiring color code shall be maintained throughout the installation.

C. Installation of equipment and devices that connect to equipment furnished under other sections, or furnished by the Owner, shall be closely coordinated with the suppliers of the equipment and with Owner.

D. After completion of the installation, Contractor shall clean the inside and the outside of the fire alarm equipment and shall remove all dirt and debris from the site.

E. Cable

1. Cable shall be installed as described in the cable installation paragraphs in the Electrical section. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

F. Raceways

1. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section.

G. Testing

1. Contractor shall notify Engineer at least 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of Engineer, Owner, LOCAL FIRE MARSHAL, or their representatives. The Contractor shall furnish

all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to Engineer. The tests shall be performed by, or under the supervision of, a qualified representative of the fire protection and signaling system manufacturer and shall include the following:

a. Verify that the system is free of grounds or open circuits. The FACP shall indicate when a ground or an open circuit exists.
b. Verify that all alarm signal devices, stations, transmitters, automatic detectors, and supervisory devices are functioning as specified.
c. Test each fire alarm device and circuit. Individually activate each manual initiating station and verify correct alarm operation and control panel response. Individually test each automatic initiating device and verify correct alarm operation, control panel response, and remote equipment operation.
d. Test battery backup systems for specified capacity.
e. Repeat test to verify correction of any defect found in the initial testing.

3.2 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

Section 31 09 13 - GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section specifies requirements for installing geotechnical instrumentation as shown on the Drawings to monitor ground movements. The Work includes furnishing and/or installing monitoring devices such as multiple point borehole extensometers and~~,~~ road prism points for measurement of ground movement of the access road to Yamaha Motor Corporation.

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B. The CONTRACTOR shall monitor the instruments, interpret the data obtained, furnish the ENGINEER the data and results, and make modifications to construction procedures if ground movements are found to be in excess of the action levels as defined in paragraph 3.07.A of this Section.

1.2 RELATED SECTIONS

A. The following Sections apply to the Work of this Section. Other Sections not referenced below shall also apply to the extent required for proper performance of this Work.

1. Section 31 23 33 – Trenching and Backfilling
2. Section 31 75 00 – Shaft Excavation Support and Protection
3. Section 31 71 00 – Tunnel Excavation
4. Section 33 05 07.23 – Trenchless Utility Crossing

1.3 SUBMITTALS

A. Conform to requirements of Section 01 33 00 - Submittals.

B. Manufacturer's printed product data on all instruments.

C. Detailed step-by-step procedures for all instruments specified herein, for installation, protection from damage, and maintenance, method of instrument removal, together with all required field and office forms. The installation procedures shall include lists of tools and materials required.

D. All qualifications as listed below. Include with all job/project references the name of the project and the names, current addresses and telephone numbers of persons representing the project owner or the project owner at the time of instrument installation.

1. Geotechnical consultant.

2. Field representative from the geotechnical consultant.

3. Drilling Subcontractor.

4. Superintendent/foreman from the drilling Subcontractor.

5. Licensed professional land surveyor.

E. If deviating from Contract Documents, submit drawings prior to beginning of trench, shaft, and tunnel excavation, showing layout of all instruments, with each type of instrumentation numbered sequentially.

F. Provide instruction manual for each instrument including the following:

1. A description of the purpose of instrument.

2. Theory of operation.

3. Step-by-step procedure for:

a. Acceptance test when instruments are received on Job Site, to ensure the instruments are functioning correctly prior to installation.
b. Calibration of instruments and readout units.

4. A list of calibration equipment required and recommended frequency of calibration.

5. Step-by-step instrument installation procedures including materials, tools, spare parts, and any borehole requirements.

6. Maintenance procedures for each instrument.

7. Data collection, reduction, processing, and plotting procedures.

G. Certification that indicates that all monitoring and testing equipment has been calibrated and maintained in accordance with the manufacturer's requirements. All calibrations shall be current within 30 days of the date the equipment arrives on Job Site.

H. Certification of compliance that all materials used as part of the instrumentation conforms to the manufacturer's quality assurance requirements.

I. Submit as-built location, elevation, and installation record sheet within five (5) days of installing each instrument to the ENGINEER. As-built location and installation record shall be prepared, signed, and sealed by the Geotechnical Consultant.

J. Records of readings:

1. The CONTRACTOR shall monitor and obtain readings of all instruments and furnish results to the ENGINEER as specified herein.

2. The displacement/deformation and water level against time shall be plotted.

3. Records shall state project name, instrument type and number, date and time of reading, and personnel carrying out the readings.

1 4. Records shall include all ~~Job~~ Site conditions that may influence the results such as air temperature; location of excavation faces; time lapse between construction and initial readings; machinery vibration; activity of progress at adjacent excavation; ground elevation at the time of instrument reading.

K. Method of protecting the instruments.

L. Method of instrument removal and backfilling.

M. Remedial action plan prepared by the CONTRACTOR's geotechnical engineer to address conditions when the limiting values (action and maximum levels) of geotechnical instruments are reached, see Paragraph 3.07.A.

1.4 QUALITY ASSURANCE

A. Install all instruments in accordance with the Contract Documents.

B. Employ a geotechnical consultant to inspect the installation of the geotechnical instrumentation specified and evaluate instances where the reading of the instruments reach the threshold values as defined in this specification. The geotechnical consultant shall have the following qualifications:

1. Be a licensed professional engineer in Alabama, specializing in geotechnical engineering.

2. Have a minimum of ten (10) years of experience in geotechnical instrumentation installation of similar type and complexity as the proposed instruments.

3. Provide a field representative with at least three (3) years of experience in installation inspection of geotechnical instrumentation and has previously inspected not less than two (2) projects of equal type and complexity as the proposed instruments. The field representative shall be present at the job Site during the entire time of installation of the instruments.

C. Employ a drilling Subcontractor to install the geotechnical instruments. The drilling Subcontractor shall have the following qualifications:

1. Have a minimum five (5) years of experience in installation of geotechnical instruments of similar type and complexity as the proposed instruments.

2. The superintendent and/or foreman shall have at least three (3) years of experience in the installation of geotechnical instruments and has previously installed not less than two (2) projects of equal type and complexity as the proposed instruments. The superintendent and/or foreman shall be present at the Job Site during the entire time of installation of instruments.

D. If using monitoring plan contained in drawings, without modification, submit a letter confirming use of the plan. If using a different plan, submit plan for approval by the ENGINEER.

E. Readings of the geotechnical instruments shall be taken by the same personnel. Should the person need to be replaced, a minimum of two (2) readings shall be carried out by both the person being replaced and his/her replacement to ensure consistent readings.

F. No geotechnical instruments will be accepted until the initial readings are obtained by the CONTRACTOR and accepted by the ENGINEER.

G. Readings of the geotechnical instrumentation shall have an accuracy of ±0.01 ft. for horizontal location and ±0.01 ft. for elevation, unless otherwise specified.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and instruments shall be new.

B. Grout: The cement grout shall be a mixture of 5.2 gallons of water per each 94-pound sack of cement.

C. Surface protection shall be flush with the ground surface in paved or other areas. For all instruments provide roadway boxes with a 5-¼ inch lock lid as indicated and manufactured by Tyler Pipe, Tyler, TX, or Bresnahan Foundry, Hatfield, MA, or acceptable equivalent.

2.2 BOREHOLE EXTENSOMETERS

1

A. The borehole extensometers shall be Model 1100 manufactured by Geokon, Inc., Lebanon, New Hampshire, or approved equal. Borehole extensometers shall be equipped with the following:

1. Groutable Anchor or Borros Type Anchor as manufactured by Geokon, Inc., Lebanon, New Hampshire, or approved equal.

2. Vibrating Wire Transducers Model 4450 (100 mm displacement) as manufactured by Geokon, Inc., Lebanon, New Hampshire, or approved equal.

3. Contractor must provide electrical signal cables with the appropriate number of pairs of wires as required to connect the corresponding number of displacement transducers in the extensometer head assembly. Cables shall be of sufficient length to route to the readout location without splicing. Cables shall be of the same source as the displacement transducers and shall be twisted pairs, 22 AWG, 7X 30 stranded copper wires with foil shields, a common drain wire and a jacket of pressure extruded PVC.

4. Vibrating Wire Readout Model No. GK-404 or GK-406 manufactured by Geokon of Lebanon, New Hampshire, or approved equal.

2.3 ROAD PRISM POINTS

A. The road prism point shall be the Polymer Road Prism as manufactured by Geo-Instruments or equal. Survey prisms shall be installed at locations shown on the Drawings. Prisms shall be mounted in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Instrumentation shall be installed as described herein, and at the locations shown on the Drawings, and where specified, or as instructed by the ENGINEER.

B. The CONTRACTOR shall provide the ENGINEER access to instrument locations and any assistance required to perform independent monitoring.

C. The CONTRACTOR shall perform monitoring and measurement of movements during trench, tunnel, and shaft excavation, at the locations indicated on the Drawings and take measurements in accordance with Section 3.05.

D. Locate conduits and underground utilities in all areas where subsurface geotechnical instrumentation is to be drilled and installed prior to any drilling. Subsurface geotechnical instrumentation locations shall be modified, as accepted by the ENGINEER, to avoid interference with existing conduits, utilities, and foundation elements. Repair any damage to underground utilities resulting from instrument installations at no additional cost to OWNER.

E. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public. Both protective housing and roadway box shall be marked.

F. A unique instrument alphanumeric identification number shall be assigned to each monitoring point. The instrument identification number shall be clearly marked and maintained on each instrument in a nondestructive manner.

G. Immediately following installation, the location of the top of all instruments shall be surveyed to provide horizontal and vertical coordinates. Data shall be provided to ENGINEER and OWNER in accordance with the submittal requirements specified herein. Re-surveying from control points shall be required as no additional cost to OWNER to address potential disturbance or resolve conflicting data.

H. Instrumentation holes drilled from the ground surface shall be subject to the same permitting and drilling requirements as those for geotechnical exploration boreholes. Obtain necessary permits for each instrument and conform to the permit requirements during drilling, installation, monitoring, and abandonment.

I. Install instrumentation, in addition to that specified herein, that CONTRACTOR deems necessary to ensure the protection of personnel and the Work, at no additional cost to OWNER. For all other instrumentation, in addition to that specified herein, CONTRACTOR shall notify the ENGINEER at least 24 hours prior to installing any such additional instrumentation. Data resulting from such instrumentation are referred to herein as CONTRACTOR's data. Such CONTRACTOR's data will be accepted by ENGINEER only if the data are obtained from instrumentation furnished, calibrated, tested, installed, and maintained as specified herein, if the data are collected and plotted as specified herein, and if submitted to ENGINEER within one month of data collection.

J. The CONTRACTOR shall interpret the monitored data and enact remedial action plan, if settlement exceeds amount specified in Paragraph 3.07.

3.2 INSTALLATION - GENERAL

A. The CONTRACTOR’s instrumentation personnel shall install instruments in accordance with the Contractor’s detailed step-by-step procedures that were submitted as specified in Paragraph 1.04C.

B. Grouting of annular space around instrument cables, casings, and standpipes shall be placed using a tremie method with side discharge ports on the tremie pipe.

1

C. Prior to installing any instrument through drill casing or augers, all material adhering to the inside of the casing or augers, and all cuttings, shall be removed thoroughly.

D. Whenever withdrawing drill casing or augers during instrument installation in a borehole, care shall be taken to minimize the length of unsupported borehole and the rate of casing or auger withdrawal. Collapse of the borehole shall not be allowed to occur. Backfill

material shall not be allowed to build up inside the casing or auger such that the instrument is lifted as the casing or auger is withdrawn. The casing or auger shall be withdrawn without rotation. The casing or auger may be omitted, if allowed by the EngineerENGINEER, only where it can be shown that instrument installation without the casing or auger will not cause collapse of the borehole or in any way adversely affect instrument installation. If casing or augers are omitted, or the Engineer ENGINEER allows withdrawal of casing or augers prior to instrument installation, the following requirements shall apply. The instrument shall be installed in the borehole in a continuous operation, starting when instrumentation materials are first placed in the borehole, and shall not be interrupted prior to complete backfilling of the borehole to the ground surface. Partially completed instrument installations shall not be left in unsupported boreholes overnight or longer without the prior written concurrence of the EngineerENGINEER.

E. The Contractor CONTRACTOR shall notify the Engineer ENGINEER at least 24 hours prior to installing each instrument.

F. The Contractor CONTRACTOR shall extend installed instrumentation and reinstall roadway boxes as necessary as grade change changes occur, and revise instrument reference elevations as necessary.

G. As each instrument is installed, an installation record sheet shall be prepared.

H. After installation, roadway boxes shall be free-draining. Roadway boxes that are not free draining shall be repaired or replaced at no additional cost to the AuthorityOWNER.

I. The CONTRACTOR shall submit updated as-built instrument location plans to the ENGINEER.

1. The first plans shall be submitted within five (5) days after completion of the first instrument installation, regardless of instrument type.

2. Updated plans shall be submitted every subsequent two (2) weeks. Updated plans need not be submitted for periods during which no instruments have been installed.

3. All instrumentation shall be installed and tested following installation in accordance with the manufacturer's recommendation.

3.3 INSTALLATION REQUIREMENTS

A. Settlement Measurements

1. Where it is impracticable to obtain ground deformation measurements because of the design of the trench, shaft or tunnel, tunneling equipment, the support systems or the accepted method of construction, propose alternative methods of measurement for the review and acceptance of the Engineer.

B. Borehole Extensometer

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1. Holes are to be drilled at the locations and orientations shown on the Drawings. Boreholes are to be nominal 3-inches in diameter or larger. The use of drilling fluids other than water shall not be permitted. Boring logs of each hole shall be created.

2. Using quick-set cement, fix the 2.875-inch PVC standpipe within the top of the borehole, leaving adequate room to place the extensometer head assembly and coupling mount within the instrumentation enclosure.

3. Using PVC cement, cement the extensometer head assembly into the coupling mount and allow to set.

4. Remove the reference plate from the extensometer head assembly and replace it with the grout plate.

5. Tape a ½-inch polyethylene grout tube to the lower anchor using black electrical tape. Do not tape the grout tube too heavily or it may be difficult to disengage it during the grouting process. Position the grout tube alongside the rod/tube assemblies and pass it through the central hole in the extensometer head assembly and grout plate.

6. Lower the instrument into the borehole, bending the assembly in a large radius as it enters the hole.

7. Adjust the rod lengths if necessary and reconnect the extensometer head.

8. Prior to grouting, lubricate the grout line by pumping a quantity of water through it. While tremieing grout (using cement grout), slowly withdraw the grout line from the hole. Do not remove the last 20 feet of grout line until undiluted grout issues from the standpipe.

9. After the casing has been installed and the grout has hardened, the Contractor shall obtain a baseline dataset of extensometer readings. Three sets of readings shall be obtained.

10. Automate the extensometer.

11. Contractor shall provide a compatible micrometer for making manual readings for the extensometers such as Model No. 1400-4 manufactured by Geokon, Inc., Lebanon, NH, or equal.

C. Road Prism Points

1. Road Prism Points shall be installed at locations indicated on the Drawings. Prisms shall be installed according to manufacturer's recommendation.

3.4 MONITORING

A. Monitoring:

1. Take initial readings of all instruments to establish a baseline and provide ENGINEER with this data, in accordance with the requirements specified herein.

2. Establish a system of geotechnical instrumentation on the ground surface for the purpose of monitoring ground subsidence resulting from trenchless excavation. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.

3. Determine the elevation and horizontal coordinates of each instrument prior to commencing excavations. Obtain readings of instrumentation in accordance with Paragraph 3.05. Provide for more frequent readings if movement accelerates, as appropriate.

4. After excavations are completed in the vicinity of instrumentation, continue taking readings for a period of two months on a weekly basis following completion of excavations or until readings stabilize.

5. Following substantial completion but prior to final completion, obtain final readings of all instrumentation.

6. In the event that deformations exceed threshold values or cause damage to existing infrastructure, immediately take precautionary measures to prevent further deformation and/or distress. Measures shall include:

   a. Notify ENGINEER.
   b. Provide for additional ground deformation instrumentation as needed to assess continued deformation and/or distress.
   c. Prepare for review by the ENGINEER an action plan to mitigate further deformation. Restore pavement surfaces to pre-construction conditions after the deformations have stabilized. Repair any damaged utilities or other facilities. Obtain written acceptance of the restoration plan from OWNER.
   d. Implement action plan.

3.5 READINGS

1

A. The CONTRACTOR ~~SHALL~~ shall collect data, following the guidelines included in the manufacturer's instruction manuals.

B. Instruments shall be read so as not to interrupt the excavation and support cycle of the work.

C. Provide for closer interval readings during periods of high precipitation or excavation proceeding adjacent to the instrument. If ground deformation monitoring is higher than

established thresholds identified in Paragraph 3.07.A, frequency of reading shall be increased.

D. Monitor movements for acceleration to verify stability of excavation. In the event that deformation exceeds the established thresholds, immediately take precautionary measures to prevent further displacement.

E. The ENGINEER, at its discretion; will make additional independent monitoring using the same readout instruments used by the CONTRACTOR. Provide monitoring equipment and access to instrumentation locations for the ENGINEER's independent monitoring. Differences between the readings by the CONTRACTOR and the ENGINEER shall be resolved by performing joint readings and data reduction using the manufacturer's instructions. The CONTRACTOR, its geotechnical consultant and the ENGINEER shall jointly participate in readings and data reduction.

F. Frequency

1. Read required instrumentation and provide ENGINEER with these data. Read the instruments using the following approximate schedule:

Instrument Type	Two Months Prior to Start of Excavation	During Excavation (within 100 feet of Excavation)	After Excavation and Prior to Backfill	After Backfill and Up to Substantial Completion
Borehole Extensometer	2 weeks	Daily	Weekly	2 weeks
Road Prism Points	2 weeks	Daily	Weekly	2 weeks
~~Road Prism Points~~	~~2 weeks~~	~~Daily~~	~~Weekly~~	~~2 Weeks~~

1

3.6 INSTRUMENT PROTECTION, MAINTENANCE, AND REPAIR

A. Protect the instruments and monitoring equipment from damage during operations. Replace or repair damaged instruments or monitoring equipment prior to resuming operations.

3.7 INTERPRETATION OF DATA AND REMEDIAL ACTION

A. When monitoring devices indicate action levels are reached, take corrective measures, and modify procedures to ensure maximum levels are not exceeded. When monitoring instruments indicate that movement equal to 90 percent of the maximum allowable has occurred, the CONTRACTOR response value is said to have been reached. At this time, the Contractor shall actively control ground movement in accordance with the submitted plan to prevent reaching the maximum or shutdown value. Measures may include adjusting tunneling and ground support installation methods, refinements to contact grouting methods and sequencing, modifying progression rates, or other as identified in the submitted action level plan procedures. When monitoring instruments indicate that movement equal to 100 percent of the maximum allowable value has occurred, the shutdown value is said to have been reached. At this time, the ENGINEER may direct the CONTRACTOR to stop all Work immediately, and the CONTRACTOR must meet with the ENGINEER to develop a plan of action before work can be resumed, unless this creates an unsafe condition. Work shall not resume until appropriate measures, in the opinion of the ENGINEER, have been undertaken to correct the performance.

B. Restoration: Restore existing facilities for all damage due to trenchless construction, shaft and trench related ground deformation in excess of allowable maximums at no additional cost to the OWNER. Damages initiated prior to reaching allowable maximum tolerances and continuing beyond maximum shall be negotiated. The CONTRACTOR shall obtain prior approval from the ENGINEER for the proposed repair methods for all facilities.

3.8 REMOVAL OF INSTRUMENTS

A. Prior to final acceptance of the work and except as otherwise indicated or directed, CONTRACTOR shall remove and dispose of all instruments in accordance with manufacturer specifications and state and local regulations and codes. All surfaces shall be restored to the condition prior to instrumentation installation. Pavement shall be repaired following the OWNER’S standards.

END OF SECTION

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Section 31 23 11 - EXCAVATION AND FILL FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers earthwork and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation; handling, storage, transportation, and disposal of all excavated material; all necessary temporary earth retention and other protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; construction of fills and embankments; grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed professional engineer in the state where the earthwork is located, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

B. Temporary ~~Excavation~~ Earth Retention System Design Certificate

1

1. Before starting construction on temporary earth retention systems, submit to Engineer the Temporary Earth Retention System Design Certificate, Figure 1 – 31 ~~23~~11. Refer to paragraph in this specification titled, “Temporary Earth Retention.”

C. Filter Fabric Data

1. Complete descriptive and engineering data for the fabric shall be submitted in accordance with the Submittals Procedures section. Data submitted shall include:

   a. A 12 inch square sample of fabric.
   b. Manufacturer's descriptive product data.
   c. Installation instructions.

D. Test Results for Review of Materials

1. Complete test results for tests performed on fill and backfill, and other material specified herein, by an independent commercial laboratory retained by the Contractor, as described in the paragraph titled, “Review of Materials”.

E. CLSM Mix Design

1. Mix design by in independent commercial laboratory retained by the Contractor.

F. Geocell Retaining Wall Design

1. Layout drawings for geocell retaining wall at rear of the Chemical Building.

1 G. Temporary Earth Retention Experience

1. Submit Contractor (or Subcontractor) experience with temporary earth retention demonstrating compliance with the requirements of this specification section.

1.4 INSURANCE

A. Professional Liability insurance shall be provided as specified in the Supplementary Conditions.

1.5 DEFINITIONS

A. The following definitions apply to this Project:

slide-rail excavation system

1 : a pre-engineered modular system consisting of movable panels, or similar pre-engineered modular system marketed as a method of support of linear vertical excavations used for installation of buried utilities but not acceptable for use as temporary earth retention on this Project

Structure footprint

1 : the area occupied by a structure at finish grade level plus 20 feet beyond those limits

temporary earth retention

1 : a system used in vertical ground support by an engineer licensed in California and retained by or employed by Contractor used to protect structures, utilities, and other infrastructure from damage caused by ground movement and; custom designed for the subsurface conditions at the Project site; which positively supports the ground during installation, and during use, backfilling of excavation, and removal, if the system is removed

2 : cantilevered or internally braced, sheet piles, secant pile walls, continuous deep soil-mixed walls; or soldier piles and wood lagging, or soil nail walls, installed in the

appropriate soils and using sequence of installation that minimizes exposure excavation face during installation, and backfilling if lagging is removed

trench shield

1 : a movable pre-engineered modular system consisting of parallel steel panels braced with struts inserted in an excavation and designed solely to shield and protect workers from ground collapse when working in an excavation, also referred to as trench box

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric

1. Filter fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

2. Filter Fabric Type B

a. Filter fabric Type B shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type B shall be a non-woven fabric consisting of only continuous chains of polypropylene filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents, and shall have the indicated properties (Minimum average roll value in weakest principal direction):
   1) Property – Grab Strength
      a) Test Method : ASTM D4632
      b) Unit : lbs Min Roll Value : 250
   2) Property – Grab Elongation
      a) Test Method : ASTM D4632
      b) Unit : percentMin Roll Value : 50
   3) Property – CBR Puncture Strength
      a) Test Method : ASTM D6241
      b) Unit : lbs Min Roll Value : 700
   4) Property – Trapezoidal Tear
      a) Test Method : ASTM D4533
      b) Unit : lbs Min Roll Value : 100
   5) Property – UV Resistance at 500 hours
      a) Test Method : ASTM D4355
      b) Unit : % Strength RetainedMin Roll Value : 100

b. The apparent opening size (diameter) for the filter fabric Type B shall be no larger than the U.S. Standard Sieve Size 70 per ASTM D4751.

3.

B. Fill and Embankment Materials

1. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of site fills and embankments. Additional material shall be provided from Contractor's offsite source.

2. All material placed in fills and embankments shall be free from rocks or stones larger than 3 inches in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.

C. Granular Fill

1. Granular fill material shall be crushed rock or gravel suitable for use as a free draining subbase beneath slabs and foundations. Granular fill shall be free from dust, clay, and trash; hard, durable, non-friable; and shall be graded 3/4 inch to No. 4 as defined in ASTM C33 for No. 67 coarse aggregate. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate. The edges of granular fill shall be confined, either by placing against an excavation face or other fill.

D. Structure Backfill

a. Structure backfill shall be defined as the material placed around and outside of structures. For structures constructed in open excavations, structure backfill shall extend to the temporary excavation slope so that the entire excavation outside the structure shall be filled with structure backfill. For structures constructed in supported excavations, the structure backfill shall completely fill the space between structure and temporary earth retention, or between structure and excavation face, if these specifications permit removal of the system. Structure backfill shall meet the following requirements: Structure fill shall be free of deleterious material
b. The maximum particle size shall be 3 inches
c. Liquid limit shall be less than 55, and plasticity index shall be less than 33
d. The minimum dry density shall be 95 pcf

1

~~2. Specifier. The specification provides some default choices and a choice for an alternate material. Onsite materials should be considered to minimize the cost of importing; however, in some situations importing will be necessary. Select structure backfill based on the recommendations of the final geotechnical report. Select a choice that closely matched the recommendations in the geotechnical report, or specify an alternate. Consider substituting a state department of transportation aggregate road base aggregate for crushed rock structure backfill and crushed rock select fill. The standard gradation specified for both crushed rock structure backfill and select fill may not be available in most states; aggregates available from suppliers may not meet the standard specification limit, 5% maximum, passing #200 sieve. If a drainable backfill is required, granular fill shall be specified and shall be shown on Drawings encapsulated in Filter Fabric Type A. When alternative fill is required include text.~~

3. Crushed Rock Structure Backfill

   a. Crushed rock for structure backfill shall meet the following gradation and quality requirements of Type A Crushed Aggregate Base per Section 825 of the ALDOT Standard Specifications for Highway Construction.

E. Select Fill

1. Select fill shall be defined as the material placed beneath the structure foundations and slabs below any granular material layer or lean concrete slab indicated on the Drawings. Select fill shall be used to replace any unsuitable material below the structure foundations and slabs and to raise the site grades below and within 5 feet horizontally(unless a different dimension is otherwise indicated on the Drawings or specified) of structural footprints and at locations indicated on the Drawings. Select fill shall meet the requirements of the previous paragraph entitled "Fill and Embankment Materials", unless the Drawings indicate crushed rock or clean sand select fill is to be used.

2. Crushed Rock Select Fill

   a. Crushed rock for select fill shall meet the following gradation and quality requirements of Type A Crushed Aggregate Base per Section 825 of the ALDOT Standard Specifications for Highway Construction.:

F. Gravel Base Beneath Slabs [Not used]

1

1. ~~"Gravel Base Beneath Slabs" is defined as material to be placed directly beneath building floor slabs as shown on the Drawings. The material shall meet the quality requirements specified for ASTM C33 concrete coarse aggregate and shall be graded No. 7 coarse aggregate.~~

G. Geocells

1. The cellular confinement system (geocell) shall be GWV30, as supplied by Presto Geosystems, or equal. The depth of the geocell shall be 6 inches unless indicated otherwise on the Drawings.

H. Controlled Low Strength Material (CLSM)

1. CLSM shall consist of a mixture of Portland cement, fly ash, sand, and water and shall be placed at locations indicated on the Drawings or as directed by Engineer. The class of CLSM shall be as specified below.

2. The type of cement in CLSM shall be as specified in the Cast-in-Place Concrete specification. The class of fly ash in CLSM shall be as specified in the Water in CLSM shall be potable.

3. Contractor shall design and test the CLSM. The mix design shall be such as to ensure that the CLSM hardens sufficiently to support the weight of an average person in one to four hours after placement and support equipment weight in 24 hours. The mixture shall be

designed such that when tested in the field with the Kelly Ball apparatus per ASTM D6024, the maximum depression diameter shall be 3 inches. CLSM shall be self-leveling and shall have an average patty diameter from 8 to 12 inches when the flow is measured in accordance with ASTM D6103.

4. The batch proportions accepted by Engineer apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the acceptance of Engineer.

5. If a change in sources of materials is proposed, a new mix design shall be developed by Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, Contractor shall develop a new mix design to get the desired results.

6. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the acceptance of Engineer.

7. Class B CLSM

   a. The initial trial mixture for Class B CLSM shall consist of the following minimum proportions per cubic yard to provide minimum compressive strength listed below:
      1) Cement : 100 lbs
      2) Fly Ash : 100 lbs
      3) Sand (SSD) : 2760 lbs
      4) Water : 386 lbs
      5) Air Entraining admixture : 5 percent
      6) Minimum compressive strength at 28 days : 200 psi

2.2 MATERIAL TESTING

A. Review of Materials

1. As stipulated in the Quality Control section, all tests required for preliminary review of materials and materials delivered to the Site shall be made by an acceptable independent testing laboratory at the expense of Contractor. Tests performed by the aggregate supplier are not acceptable. Tests shall have been performed within 2 months of submittal and shall be representative of the material that will be delivered to the Site. Acquisition of samples for testing, both for preliminary review of materials and for testing of materials at the Site, shall be by the Contractor's independent testing laboratory. Samples acquired at the Site shall be obtained after placement and compaction of the material. Aggregate material shall be sampled in accordance with ASTM D75.

2. Two initial gradation tests shall be made for each type of general fill, select fill, structure backfill, granular fill, or other specified material~~, and one additional gradation test shall be made for each additional 500 tons of each material delivered (imported) to the jobsite or suitable onsite material incorporated in select fill or structure backfill~~. In addition, one set of initial Atterberg Limits test shall be made for each fill material containing more than 20 percent by weight pass the No. 200 sieve and for materials specified by Atterberg Limits.

3. All material testing on CLSM shall be made by an independent testing laboratory ~~at the expense~~ retained by the ~~of~~ Contractor.

B. Field Testing Expense

1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of Owner.Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

C. ~~Required~~ Field and Laboratory Tests

1. For planning purposes, the Owner's testing laboratory will use the following general guidelines for frequency of field tests. Additional tests will be performed as necessary for job conditions and number of failed tests.

   a. For area fills and embankments, an in-place field density and moisture test for each 1000 cubic yards of material placed.
   b. One in-place field density and moisture test for every 100 to 200 cubic yards of structure backfill or select fill.
   c. One in-place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
   d. At least one test for every full shift of compaction operations on mass earthwork.
   e. Testing of CLSM will be as follows.
      1) Compressive Strength. For every 200 cubic yard of CLSM placed, prepare, cure, remove from molds, and test four 6 by 12 inch test cylinders in accordance with ASTM D4832. Cure cylinders in the molds in accordance with ASTM D4832 until time of testing, at least 14 days. Two cylinders will be tested at 7 days and the other two cylinders will be tested at 28 days.
      2) Flow. Once each day, the CLSM material will be tested for flow in accordance with ASTM D6103.
      3) Unit Weight, Yield, and Air Content. Once each day that CLSM fill is placed, unit weight, yield and air content will be determined in accordance with ASTM D6023.
      4) Penetration. Once a day that CLSM is placed, the resistance to penetration from ball-drop apparatus (Kelly Ball) will be measured in accordance with ASTM D6103. (Compliance will be based on maximum depression diameter of 3 inches.)

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments and sites to be occupied by permanent construction shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil.

All waste materials shall be removed from the site and disposed of by and at the expense of Contractor.

3.2 EXCAVATION

A. General

1. Permanent excavations shall conform to the lines and grades indicated on the Drawings. Temporary excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

2. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

B. Classification of Excavated Materials

1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

C. Preservation of Trees

1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from damage by construction operations.

D. Unauthorized Excavation

1. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced with concrete or lean concrete at the expense of Contractor. If structural concrete replacement is chosen, it shall be with concrete placed at the same time and monolithic with the concrete foundation.

E. Dewatering

1. Dewatering shall comply with the requirements of specification Section 31 23 19 - Dewatering.

F. Temporary Earth Retention

1. Except where excavation side slopes are cut to a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding. Temporary earth retention systems shall be furnished and installed as necessary to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower

structures, and to protect adjacent structures, utilities, and other facilities from damage when installing, during excavation, and during backfill and removal of system..

2. Before installing a temporary earth retention system, the Contractor shall ensure that the temporary earth retention design engineer shall complete the Temporary Earth Retention System Design Certificate (Figure 1 – 31 23 11), and the Contractor shall submit the certificate along with proof of professional liability insurance for the earth retention designer. The Contractor shall submit a separate certificate for each unique design.

3. Temporary earth retention shall be designed specifically for the site and subsurface conditions of the Project. Acceptable methods of temporary earth retention include sheet piles, soldier piles and lagging, soil nail walls, secant pile walls, structural diaphragm walls, soil mixed walls installed with structural elements, or other systems acceptable to the Engineer. Trench shields (i.e. trench boxes) are manufactured for protecting workers in trenches and shall not be used for temporary earth retention. Slide rail systems and other pre-engineered modular systems are not acceptable for use as temporary earth retention on this Project.

4. Minimum requirements for temporary earth retention design shall include:.

    a. No sloping temporary excavation is allowed within a horizontal distance 'H' of outside edge of foundation of an existing structure or outside edge of utility, where H is equal to 2D; and 'D' is defined as the vertical distance between bottom of foundation, or centerline of utility, and the bottom of adjacent temporary excavation.
    b. Temporary earth retention shall extend from the existing grade to the bottom of excavation when the earth retention is within a horizontal distance 'H' of edge of foundation or centerline of utility, unless otherwise acceptable to Engineer.
    c. The horizontal deflection of top of cantilever earth retention elements shall be 0.85 percent of the retained height or less to control ground movement adjacent to structures and utilities. But in no case shall the top of cantilever earth retention elements exceed 1.50 inches.
    d. The horizontal deflection of braced earth retention systems elements shall not exceed 1.00 inches.
    e. When the upper portion of the excavation consists of a slope and the lower portion of excavation is supported by a temporary earth retention system, the toe of slope and the retained earth side (i.e. back side) of the earth retention elements shall be separated by a minimum fifteen (15) foot wide horizontal bench, unless indicated otherwise on the Drawings.
    f. If the soldier pile and lagging method is used for temporary earth retention, the lagging used shall only be seasoned hardwood, with maximum board width (vertical height) of 12 inches. The lagging boards shall be installed from the top down as the excavation advances. The use of steel plate lagging or other types of lagging is not acceptable. The work crew responsible for installation of soldier piles shall also install the wood lagging. No earth faces shall be exposed between work shifts.
    g. Temporary earth retention shall be installed using methods that prevent vibration damage to adjacent facilities and prevent settlement to avoid damaging adjacent structures and utilities.
    h. When temporary sloping excavations are used that abut the temporary earth retention system, Contractor shall submit a certification from a professional

engineer, licensed in Missouri, that sloping portions of excavation are stable based on site and subsurface soil conditions and duration the slope will be in place. The citation of OSHA slopes as a basis of the certification is unacceptable.

i. The Contractor performing the temporary earth retention shall have experience on a minimum of ten (10) projects installing temporary earth retention. Acceptable experience includes sheet piles, soldier piles and timber lagging, secant piles, and soil nailing. Experience using slide rails or other pre-engineered shoring systems or trench shields will not be accepted. Contractor's temporary earth retention designer shall have experience in design of temporary earth retention on at least five (5) projects. Design experience that used slide rails or other pre-engineered shoring systems or trench shields will not be accepted

j. Unless the excavation support is required to be left in place the design of the excavation support system shall be such as to permit complete removal while maintaining stability of the excavation. Excavation support systems to be left in place shall be designed and constructed of only steel. No additional payment above the Contract Price will be made for excavation support components left in place. Excavation support elements left in place, shall be cut off 24 inches minimum below the finish grade indicated on the Drawings.

G. Foundation Subgrade Preparation

1. Subgrades for foundations shall be prepared using the ~~same~~proofrolling procedure as required for fills and embankments. If the foundation area is too small to accommodate the proofrolling equipment, the Engineer shall select an alternative method of verifying adequacy of the foundation subgrade. After preparation, foundation subgrades shall be firm, dense, and thoroughly compacted and consolidated; and shall be sufficiently stable to remain firm and intact under the feet of the workers. Reinforcing steel and concrete shall be placed as soon as possible after subgrade preparation. Subgrades that are disturbed due to weather or other conditions shall be repaired by removing the disturbed material and replacing with crushed rock select fill. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

H. Roadway Excavation

1. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the Drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 6 inches [150 mm] and shall meet the following:

   a. Test method to determine maximum density and moisture : ASTM D698.
   b. Relative compaction and moisture content relative to the optimum : 95%.
   c. Moisture content relative to the optimum : -2% to +2%, granular soil; -3% to +3%, cohesive soil.

2. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

3.3 FILLS AND EMBANKMENTS

A. Fills and embankments shall be constructed to the lines and grades indicated on the Drawings. Fills and backfills placed beneath and around structures shall comply with the requirements of this specification for select fill and structure backfill, respectively. Construction of fills and embankments shall begin from the lowest elevation in each excavation or area and progress upward. Materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness. Unless otherwise specified herein, the following governing standards apply:

1. Test method to determine maximum density and moisture : ASTM D698.

2. Relative compaction : 95%.

3. Moisture content relative to the optimum : -2% to +2%., granular soil-3 % to +3% cohesive soil.

B. Where new fill is placed adjacent to an existing sloping surface steeper than 6 horizontal to 1 vertical, the existing slope shall be benched in advance of placement of new fill. The bench shall be of sufficient width to allow compaction of the junction between the new fill and existing earth surface.

C. Backfilling of excavations and construction of fills and embankments during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

D. Subgrade Preparation

1. After preparation of the fill or embankment site, the subgrade shall be scarified and moisture conditioned to a minimum depth of 6 inches , leveled and compacted to the same relative compaction and moisture content relative to optimum as specified for fill.

2. Unless otherwise directed by Engineer, the subgrade shall be proof-rolled by a rubber-tired roller, a loaded dump truck, or other suitable rubber-tired equipment acceptable to Engineer. A minimum of four passes of the proof-rolling equipment shall be provided such that the last two passes are made perpendicular to the first two passes.

3. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with compacted fill.

E. Placement and Compaction

1. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches in un-compacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

2. Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried to achieve the moisture content relative to optimum as specified above, and shall be thoroughly mixed to ensure

uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to the required degree of compaction at the required moisture content. If the material fails to meet the specified density, compaction methods shall be altered. The changes in compaction methods shall include, but not be limited to, changes in compaction equipment, reduction in uncompacted lift thickness, increase in number of passes, and better moisture control.

3. Wherever a pipe is to installed within a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench for pipe installation is excavated.

F. Borrow Pits

1. Borrow pits are not allowed on the Site.

3.4 FILL AND BACKFILL FOR STRUCTURES

A. Earth and aggregate materials placed for structures include granular fill, structure backfill, select fill, gravel base beneath slabs, and controlled low strength material. In addition to the specific requirements specified herein, all requirements for placement of fills and embankments shall apply to granular fill, structure backfill, select fill, and gravel base beneath slabs. These requirements include, but are not limited to subgrade preparation, lift thickness, and moisture conditioning requirements. All fills and backfills for structures shall be constructed to the lines and grades indicated on the Drawings. Backfilling and construction of fills during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

B. Granular Fill

1. Granular fills shall be provided where indicated on the Drawings. Granular fills shall be placed on suitably prepared sub-grades in uncompacted lift thickness of 6 inches or less and compacted by vibration. Granular fills shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254. If the thickness of the granular fill is less than 6 inches, the compaction shall be by a minimum four passes (round trips) of a self-propelled or walk-behind type vibratory roller operating in full vibration mode in accordance with manufacturer's instructions.

2. Where granular fills are to be covered with concrete, the top surface shall be graded to the required sub-grade elevation. The completed fill shall be covered by polyethylene film as specified in Section 03 15 19 – Concrete Joints and Accessories.

C. Structure Backfill

1. Backfill materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness and shall meet the following requirements:

a. Test method to determine maximum density and moisture : ASTM D698

b. Relative compaction : 98_ %.
c. Moisture content relative to the optimum : -2% to +3%.

2. Compaction of structure backfill shall be performed in such a manner that damage to the structure is prevented. The compaction equipment used within 8 feet of the walls and for the top 8 feet [2.4 m] of backfill shall have no restriction on type. Limit of equipment weight shall be. 2 ton . __ . Compaction of structure backfill by inundation with water will not be permitted.

3. No backfill shall be deposited or compacted in water.

4. Care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a pipe is to be installed within structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe before the trench for pipe installation is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

D. Select Fill

1. Select fill shall be placed in approximately horizontal layers in uncompacted lift thickness of 8 inches or less and shall meet the following requirements:

a. Test method to determine maximum density and moisture : ASTM D698.
b. Relative compaction : 95%.
c. Moisture content relative to the optimum : -2% to +2%.

E. Gravel Base Beneath Slabs [Not used]

1

~~1. The gravel base beneath building floor slabs shall be placed in uncompacted lift thickness of 6 inches or less and compacted with a minimum of four passes (round trips) of a self-propelled or walk-behind type vibrating roller. The roller shall be operated in the full vibrating mode and in accordance with the manufacturer's instructions.~~

F. Geocells

1. Geocells used in retaining walls shall be placed in accordance with the geocell Supplier’s instructions. The geocell fill shall be concrete fill or granular fill as indicated on the Drawings. The concrete and granular fill shall be placed in accordance with the Supplier’s instructions. The geocells shall be expanded to the proper dimensions prior to filling. When used in a retaining wall, the geocells shall be installed such that the exposed face of retaining wall has a batter of 12:1, vertical to horizontal.

G. Controlled Low Strength Material (CLSM) Fill

1. CLSM shall not be placed on frozen ground. Batching, mixing, and placing of CLSM may be started when weather conditions are favorable and when the temperature is at least 34°F and rising. At time of placement of CLSM the temperature shall be at least 40°F . Mixing

and placing shall stop when the temperature is 38°F and falling. Each filling stage shall be as continuous an operation as is practicable.

2. CLSM shall be discharged from the mixer by an acceptable procedure into the area to be filled. CLSM shall be placed to limits indicated on the Drawings. Mixing CLSM with in-situ soil shall be avoided.

3. When CLSM is placed as backfill against structures, the fill shall be placed in lifts of 2 to 3 feet and the next lift shall not be placed until the previous lift can support the weight of workers without indenting the surface and at least 16 hours have elapsed from the end of placement. Lift thickness shall be reduced as necessary to prevent floatation of the structure.

4. When CLSM is placed over culverts or pipelines, they shall be anchored to prevent flotation during the placement of CLSM. Unless otherwise required, CLSM shall be placed to one foot below the finished grade elevation if the finished grade elevation is not more than 5 feet over the top of the culvert or pipe. If the finished grade is more than 5 feet over the top of the culvert or pipe, CLSM shall be placed to an elevation 2 feet over the top of the culvert or pipe, and the remainder shall be backfilled with the specified backfill or as indicated on the Drawings.

3.5 FILTER FABRIC INSTALLATION

A. Filter fabric shall be placed as specified herein and at the locations specified or otherwise indicated on the Drawings.

B. Filter fabric shall be protected from contamination by foreign material and damage. Any contaminated or damaged filter fabric shall be replaced with new filter fabric at no additional cost to the Owner. The fabric shall be covered within 7 calendar days after placement.

C. The subgrade for placement of filter fabric shall be smooth and free of irregularities and undulations. Filter fabric shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. Type A and B filter fabric shall be overlapped a minimum of 2 feet between adjacent roll ends and adjacent strips.

1 D. The joints of Type C filter fabric shall be sewn ~~unless otherwise~~ or overlapped as recommended by the manufacturer for the specific application. All seams shall be formed by mating the edges of the filter fabric panels and sewing them together with continuous stitches located a minimum of three inches from the edges. The thread shall be ultraviolet light resistant and manufactured from the same material as the filter fabric. A two-thread, type 401 double-lock stitch shall be used for all sewn work. Sewing methods shall conform to the latest procedures recommended by the filter fabric manufacturer. The Contractor shall demonstrate that the seam efficiency meets the requirements of the specified tabulated properties for the filter fabric as applicable.

E. All filter fabric placed shall be fixed to the subgrade to prevent filter fabric slippage or movement during placement of subsequent materials. Pins or staples shall not be used to fix the filter fabric to the subgrade when a geomembrane is to be placed on top of the filter fabric.

F. The Contractor shall exercise care during filter fabric installation to prevent damage to the prepared supporting subgrade surface. The Contractor shall exercise care to prevent the entrapment of rocks, clods of earth or other material which could damage the filter fabric, clog the filter fabric or hamper seaming. Filter fabric damaged or distressed by foreign objects shall be repaired or replaced.

G. No foot traffic will be allowed on the filter fabric except with approved smooth-sole shoes. The Contractor shall not use the filter fabric surface as a work area or storage area for tools and supplies.

H. Tracked or rubber tired construction equipment shall not be operated directly upon the filter fabric until a minimum thickness of 6 inches of the cover material is placed over the filter fabric. Turning of construction vehicles shall be minimized to avoid distorting or damaging the filter fabric. All damaged filter fabric shall be replaced at Contractor's expense.

3.6 FINAL GRADING AND PLACEMENT OF TOPSOIL

A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Any additional topsoil required to provide the required minimum thickness shall be at no additional cost to the Owner.

B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris. Seeding and sod placement shall be in accordance with the Seeding and Sodding Section.

3.7 DISPOSAL OF EXCAVATED MATERIALS

A. Suitable excavated materials may be used in fills and embankments as needed. All excess excavated material shall be disposed of off the Site at the expense of Contractor.

B. All debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, Contractor.

3.8 SETTLEMENT

A. Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

1

TEMPORARY EARTH RETENTION SYSTEM
DESIGN CERTIFICATE – Figure 1 – ~~02200~~31 23 11

I, the undersigned professional engineer licensed in Alabama, hereby certify that the temporary earth retention system (as defined in specification Section 31 23 11) for the _____(structure name) has been designed by me, and is in compliance with the Contract Documents.

Name: _____ Alabama P.E. Number: _____

Signature: _____

Date: _____

_____
(Seal)

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SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers responsibilities and execution for dewatering of excavations for structures and pipelines. Dewatering involves lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of excavated slopes and tunnel excavations, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures or other installations.

B. Dewatering consists of the design, furnishing, installation, operation, maintenance, monitoring, reporting, and removal of dewatering system(s) to achieve completion of Work under this Contract without causing damage to adjacent facilities, improvements, and materials.

C. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

D. The CONTRACTOR shall provide, operate, and maintain dewatering systems for the construction shown on the Drawings. The dewatering systems shall be provided to remove and dispose of groundwater and all water, regardless of the source, entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. The dewatering systems shall include any deep wells, wellpoints, sumps, and other equipment, appurtenances, and related earthwork necessary to perform the function. The dewatering systems shall dispose of the water so as not to cause injury to public or private property, cause a nuisance or a menace to the public, or adversely impact the water quality of adjacent creeks.

1.2 RELATED SECTIONS.

A. Related sections include, but are not necessarily limited to the following:31 01 0001 74 00

1. Section 31 23 11 – Excavation and Fill for Structures

2. Section 31 23 33 – Trenching and Backfilling

3. Section 33 75 00 – Shaft Excavation Support and Protection

1.3 QUALITY ASSURANCE.

A. The CONTRACTOR shall employ a specialty dewatering Subcontractor with experience in the field of large dewatering system design, installations, operation, and maintenance. The CONTRACTOR shall document successful completion of at least five (5) projects in soils and groundwater conditions similar to the project.

B. The CONTRACTOR's dewatering system shall be designed by a professional engineer licensed in Alabama and experienced in the design, installation, and operation of dewatering systems. The design shall acknowledge the type of excavation and excavation support system proposed for the project.

1.4 SUBMITTALS.

A. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with Section 01 33 00 - Submittals.

B. As a minimum, submit the following for each dewatering system used:

1. Drawings indicating the location, size, and details of deep wells, piezometers, eductors, wellpoints, sumps, vacuum headers, flow rate meters, discharge lines, means to clarifier discharge water, and any other groundwater control system component.

2. Capacities and details of pumps, prime movers, and standby equipment.

3. Design calculations proving adequacy of system and selected equipment.

4. Well and well point development procedures.

5. Detailed description of the dewatering schedule, operation, maintenance and well abandonment procedures.

6. Elevations of projected drawdown in wells.

7. Detailed description of methods for controlling settlement of existing utilities and structures.

8. Estimated dewatering system discharge flow rate.

C. Submit the following records upon completion of initial dewatering system installations:

1. Installation and development reports for well points, eductors, and deep wells.

2. Installation reports and baseline readings for piezometers and monitoring wells.

3. Baseline analytical test data of water from monitoring wells.

4. Initial flow rates.

D. Submit the following records weekly during dewatering operations:

1. Records of flow rates and piezometric elevations obtained during monitoring of dewatering operations.

2. Changes in elevations of reference points to detect settlement in adjacent structures and utilities.

3. Maintenance records for ground water control installations, piezometers and monitoring wells.

4. Water quality testing results as required by regulatory agencies and specified in discharge permits.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. CONTRACTOR shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in CONTRACTOR's operations. The permits shall be obtained prior to start of construction.

B. CONTRACTOR shall maintain dewatering system such that it is in continuous operation without any interruptions. Direct point discharges from dewatering operations to the adjacent streams or ditches are prohibited. The CONTRACTOR shall provide at a minimum, a sediment/clarification basin before conveying the water into the existing storm drainage system. The CONTRACTOR shall submit location, size, and layout of basin and discharge details and location. The CONTRACTOR shall coordinate and cooperate with the OWNER and adjust its dewatering operations as required to comply with the provisions of the OWNER’s Stormwater Pollution Prevention Plan for the Job Site.

C. CONTRACTOR shall supply a separate electrical service for dewatering and dedicate it solely to the operation of the dewatering systems.

D. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 24 inches, beneath such excavations. The specified dewatering depth

shall be maintained below the prevailing bottom of excavation at all times. The dewatering system including piezometers for monitoring progress of dewatering shall be installed and placed in operation (pumping of groundwater carried out) for at least 2 weeks prior to beginning any excavation. Once excavation begins dewatering efforts shall be continued to maintain the groundwater levels below the specified minimum depth below the prevailing excavation bottom levels at all times. Additional wells, well points, and other means of dewatering shall be installed as necessary to lower and maintain the groundwater to the specified minimum levels.

E. At least two piezometers shall be installed around each excavation to monitor the groundwater levels during dewatering. Dewatering operations shall be performed in a manner that the groundwater level is maintained to the specified level as evidenced by the water level in the piezometers.

F. CONTRACTOR shall keep excavations free of water during excavation, construction of structures, installation of pipelines, and placing of materials described in Sections 31 23 11, Excavation and Fill for Structures, and 31 23 33 Trenching and Backfilling, as applicable. CONTRACTOR shall control surface runoff so as to prevent entry or collection of water in excavations or in other isolated areas of the site. The dewatering system will include any deep wells, well points, pumps, and other equipment, appurtenances, and related earthwork necessary to perform the function. The design and operation of the dewatering system shall prevent removal of natural soils.

G. CONTRACTOR shall not start dewatering prior to the ENGINEER's review of submittal of the method, installation, and details of the proposed dewatering system. Wells shall be drilled, developed, operated, and abandoned in conjunction with state and local requirements.

H. CONTRACTOR shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

3.2 INSTALLATION.

A. Wells, Wellpoints, and Dewatering Effluent Pipelines.

1. Wells and wellpoints shall be considered the primary dewatering system and shall be designed and of sufficient number to accomplish the specified dewatering. Develop all wells and wellpoints after installation to remove fines from drilling and construction activities. Dewatering effluent pipelines shall be properly sized and have the required pressure rating to discharge the dewatering flows.

B. Sumps.

1. Construct sumps to collect any seepage that bypasses the primary dewatering system to maintain the excavation in a dewatered condition. The CONTRACTOR shall size cased sumps such that they maintain the excavation in a dewatered

condition. CONTRACTOR shall size sump pumps and all piping to remove all anticipated groundwater and stormwater runoff.

C. Dewatering System Protection.

1. Protect all dewatering wells throughout construction. Wells and dewatering effluent pipelines damaged during the construction shall be reinstalled and redeveloped at no additional cost to the OWNER.

D. Standby Equipment.

1. Maintain on Job Site sufficient equipment and materials for necessary modifications and to ensure continuous and successful operation of the dewatering and monitoring systems for all ordinary emergencies including power outage and flooding. Provide one hundred percent standby electrical generating capacity with automatic switching from engine to generator, including all safety features to prevent back-feeding the electrical supply system. Provide at least 25 percent standby pumps or provide contingency detail for delivery of additional pumps to the site within 24 hours. CONTRACTOR shall maintain standby pumps fueled and in operational condition at all times. Test all standby pumps and generators weekly to ensure their immediate availability.

E. Maintenance.

1. CONTRACTOR shall maintain excavation in a dewatered condition continuously and without interruptions. System maintenance shall include 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components for dewatering systems, standby and spare equipment, and any other work required to maintain the systems. Dewatering shall be a continuous operation and shall not be interrupted due to power outages or any other reason.

3.3 FIELD QUALITY CONTROL.

A. CONTRACTOR shall monitor dewatering effluent daily for visual signs of sediment. CONTRACTOR shall record and make available to the ENGINEER on a daily basis the location and number of dewatering wells and sump pumps in operation, ground water levels, total flow indicated on the flow meters, and the rate of flow at the time of the recordings. Consistency is an important factor in ensuring that water level data are accurate; therefore, assign and make known to the ENGINEER specific member(s) of CONTRACTOR’s workforce responsible for collecting and reporting the required information. CONTRACTOR shall perform any additional testing or monitoring as necessary to assure provision of a properly functioning dewatering system. Initially, CONTRACTOR shall test the dewatering effluent weekly for a one month time period, and shall test effluent accordingly to comply with all state of Alabama permits.

3.4 DEMOBILIZATION.

A. Upon written authorization of the ENGINEER, remove all dewatering system elements with the exception of those piezometers so designated by the ENGINEER.

END OF SECTION

Section 31 23 33 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching; the handling, storage, transportation, and disposal of all excavated material; temporary earth retention and protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed or registered professional engineer, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

B. Certifications.

1. Submit the Temporary Earth Retention Design Certificate, Figure ~~1~~2 – 31 23 ~~11~~33~~, in accordance with Excavation and Fill for Structures specification~~. The Contractor shall submit a separate certificate for each unique design. Refer to paragraph in this specification titled, “Temporary Earth Retention.”

C. Filter Fabric Data

1. Complete descriptive and engineering data for the fabric shall be submitted. Data submitted shall include:

a. A 12 inch square sample of fabric.
b. Manufacturer's descriptive product data.
c. Installation instructions.

D. Embedment and Backfill Materials

1. Complete test results covering tests performed by an independent commercial testing laboratory retained by the Contractor for ~~all~~ materials described in the Materials Testing section shall be submitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric

1. Filter fabric shall be as specified in the Excavation and Fill for Structures section.

B. Backfill Materials

1. Job Excavated Material

a. Job excavated material may be used for either uncompacted or compacted trench backfill when the job excavated material is finely divided and free from debris, organic material, cinders, corrosive or deleterious material, and stones larger than 3 inches in greatest dimension. Masses of moist, stiff clay shall not be used.

2. Crushed Rock

a. Crushed rock for compacted trench backfill shall conform to the requirements of crushed rock structure backfill as specified in ~~the~~ specification Section 31 23 11 - Excavation and Fill for Structures specification section.

C. Controlled Low Strength Material (CLSM) Fill

1. CLSM shall consist of a mixture of Portland cement, fly ash, sand, and water and shall be placed at locations indicated on the Drawings or as directed by Engineer. The class of CLSM shall be as specified below.

2. The type of cement in CLSM shall be as specified in the Cast-in-Place Concrete specification. The class of fly ash in CLSM shall be as specified in the Cast-in-Place Concrete specification. Water in CLSM shall be potable.

3. Contractor shall design and test the CLSM and submit the mix design and test results to Engineer for review and acceptance. Initial set time shall be 8 hours plus or minus one hour as determined by ASTM C403. CLSM shall have an efflux time of 10 to 26 seconds through a special flow cone with a 1/2 inch discharge tube.

4. The batch proportions accepted by Engineer shall apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the acceptance of Engineer. If a change in sources of materials is proposed, a new mix design shall be developed by Contractor before the new material is used. When unsatisfactory results or other

conditions make it necessary, Contractor shall develop a new mix design to obtain the desired results.

5. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the acceptance of Engineer.

6. Class A CLSM

a. The initial trial mixture for Class A CLSM shall consist of the following minimum proportions per cubic yard:
1) Cement 50 lb
2) Fly Ash 250 lb
3) Sand (SSD) 2860 lb
4) Water 370 lb
5) Air Entraining Agent 6 percent
6) Compressive strength range at 56 days 100-150 psi

D. Pipe Embedment Material

1. Pipe embedment material shall be placed as indicated in Figure 1-02202

2. Granular Embedment

a. **[**Granular embedment shall consist of crushed rock and crushed gravel, meeting the quality and gradation requirements of coarse aggregate size number 7 of ASTM C33.

3. Hand Placed Embedment

a. Hand placed embedment shall be finely divided job excavated or imported material, free from organic materials, debris, and stones.

4. Compacted Embedment

a. Compacted embedment shall be finely divided job excavated material free from debris, organic material, and stones. ~~Graded gravel~~Crushed rock may be substituted for compacted embedment. Granular embedment may be substituted for all or part of the compacted embedment at the option of the Contractor.

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2.2 MATERIALS TESTING

A. Preliminary Review of Materials

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~~1.~~ As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of embedment, fill, backfill, or other material~~, and one additional gradation test shall be made for each additional 500 tons of each material delivered to the site~~. In addition, one set of initial

Atterberg Limits test shall be made for each fill materials containing more than 20 percent by weight passing the No. 200 sieve . ~~One additional Atterberg Limits test shall be made for each additional 500 tons of each material delivered to the site.~~

2. All material testing on CLSM shall be made by an independent testing laboratory ~~at the expense of~~ retained by the Contractor.

B. Field Testing Expense

1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of ~~Contractor~~ Owner. Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

C. ~~Required~~ Field and Laboratory Tests

1. For planning purposes, the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as specified in the Submittals Procedures section.

   a. Two moisture density (Proctor) tests in accordance with ASTM D698 (or, when required, ASTM D1557), or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general fill, designated fill, backfill, or other material proposed.
   b. In-place field density and moisture tests (ASTM D6938) at intervals of 1000 feet maximum along the trench.
   c. One in-place field density and moisture test (ASTM D6938) for every 200 cubic yards of backfill.
   d. One in-place density and moisture test (ASTM D6938) whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
   e. Additional gradation, Proctor, and relative density tests whenever the source or quality of material changes.
   f. Testing of CLSM shall be as follows:
      Compressive Strength. For every 200 cubic yards of CLSM placed, fill four 6 by 12 inch plastic cylinder molds to overflowing and then tap sides lightly. Cure cylinders in the molds covered until time of testing, at least 14 days. Strip the cylinders carefully using a knife to cut away the plastic mold. Cap the cylinders with high strength gypsum plaster or other capping process that will not break these low strength materials. Test cylinders in accordance with ASTM C39. Two cylinders shall be tested at 7 days and the other two cylinders shall be tested at 56 days.
      Flow of ~~Fill~~ CLSM. Once each day that CLSM is placed, test the fill material in accordance with ASTM C939 for the efflux time. Wet screening may be required to remove coarse particles.
      Unit Weight and Yield. Once each day that CLSM is placed, determine unit weight and yield in accordance with ASTM C138.
      Air Content. Once each day that CLSM is placed, determine air content in accordance with ASTM C231.

Penetration Resistance. Once each day that CLSM is placed, determine early bearing strength in accordance with ASTM C403 penetration procedure.

PART 3 - EXECUTION

3.1 CLEARING

A. All clearing shall be performed as necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.

3.2 EXCAVATION

A. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

B. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

1 ~~C. Except where exterior surfaces are specified to be damp-proofed, monolithic concrete manholes and other concrete structures or parts thereof, which do not have footings that extend beyond the outside face of exterior walls, may be placed directly against excavation faces without the use of outer forms, provided that such faces are stable and also provided that a layer of polyethylene film is placed between the earth and the concrete.~~

1 ~~D. Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches clearance is provided for outside plastering.~~

E. Classification of Excavated Materials

1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

1 ~~2. Classification of excavated materials shall be made as follows:~~

~~a. Rock. Rock is defined as being sandstone, limestone, flint, granite, quartzite, slate, hard shale, or similar material in masses more than 1 cubic yard in volume or in ledges 4 inches or more in thickness.~~
~~Should rock be encountered in two or more ledges, each ledge being not less than 3 inches thick and with interlying strata of earth, clay, or gravel not more than 12 inches thick in each stratum, the entire volume between the top of the top ledge and the bottom of the bottom ledge will be classified as rock.~~

~~b. Earth. All material not classified as rock.~~

F. Preservation of Trees

1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from permanent damage by construction operations.

2. For limits of tree removal along pipeline routes, see **[**the Temporary Facilities section under "Protection of Public and Private Property".**]**~~**[***Insert alternative*~~**]**

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G. Blasting

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1. Blasting or other use of explosives for excavation is not allowed.

H. Dewatering

1. Dewatering shall comply with the requirements of specification Section 31 23 19 – Dewatering ~~equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure or tunnel to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result~~.

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~~2. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of**[**24 inches , beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.~~

~~3. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.~~

~~4. Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.~~

~~5. Contractor shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in Contractor's operations. The permits shall be obtained prior to start of construction.~~

I. Temporary Earth Retention ~~Sheeting and Shoring~~

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1. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported with ~~steel sheet piling and shoring t~~temporary earth retention as necessary to prevent caving or sliding. The requirements of temporary earth retention in specification Section 31 23 11 – Excavation and Fill for Structures also apply to this specification section.

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2. ~~Sheet piling or other excavation support~~ Temporary earth retention systems shall be installed as necessary to limit the extent of excavations for deeper structures and to

protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for~~,~~ and shall install adequate protection systems for prevention of damage to existing facilities.

3. ~~Sheeting, shoring and excavation support~~ Temporary earth retention systems shall be designed by a professional engineer ~~registered in the state where the project is located~~ licensed in Alabama. Before installing a temporary earth retention system, the Contractor shall ensure that the temporary earth retention design engineer shall complete the Temporary Earth Retention System Design Certificate (Figure 2 - 31 23 33), and the Contractor shall submit the certificate along with proof of professional liability insurance for the earth retention designer. The Contractor shall submit a separate certificate for each unique design.

4. ~~Trench sheeting may be removed if the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting.~~ Trench ~~sheeting~~support shall ~~not be pulled after~~ be removed sequentially during backfilling. Where trench ~~sheeting~~ support is left in place, it shall not be braced against the pipe~~, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe~~. ~~Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.~~ Trench ~~sheeting~~ support shall be removed unless, in the opinion of Engineer, removal of the sheeting will cause damage to the facility it is protecting or loss of necessary piping support from the piping embedment. If left in place, the ~~sheeting~~support shall cut off 36 inches below finished grade. The design of the support system shall be such as to permit complete removal while always maintaining ~~safety and~~ stability ~~at all times~~.

~~5. A movable trench support may be used, provided care is exercised in placing and moving the trench box or support bracing to prevent movement of the pipe and bedding and backfill material meets the required compaction without voids.~~

J. Stabilization

1. ~~Sub-grades~~ Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

~~2. Sub-grades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the Drawings.~~

3.3 TRENCH EXCAVATION

A. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. One block or 400 feet , whichever is the shorter, shall be the maximum length of open trench on any line under construction.

B. Except where tunneling is indicated on the Drawings, is specified, or is permitted by Engineer, all trench excavation shall be open cut from the surface.

C. Prior to excavation, Contractor shall contact local underground alert hotlines, "Dig Safe" and/or individual utility owners for marking underground utilities. Once utilities are marked, Contractor shall hand dig or pothole to expose the existing utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.

D. Alignment, Grade, and Minimum Cover

1. The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.

2. Where pipe grades or elevations are not definitely fixed by the Drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of _36__ inches over pipes below paved and graded streets and, of __24_ inches over pipes in other locations. Greater pipe cover depths may be necessary on vertical curves or to provide adequate clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation, except where future surface elevations are indicated on the Drawings.

~~E. Maximum Trench Widths~~

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~~1. Maximum trench widths shall be limited as indicated in Schedule [02202-S01][31-23-33] for designated conduits. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment. However, the limiting trench widths from the bottom of the trench to an elevations 12 inches above the top of installed pipe, and the minimum permissible sidewall clearances between the installed pipe and each trench wall, shall be as indicated in Schedule [02202-S01][31-23-33-S01] or on the Drawings.~~

~~2. Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.~~

~~3. Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits. Slopes shall not extend lower than 12 inches above the top of the pipe.~~

~~4. If, for any reason, the width of the lower portion of the trench, as excavated at any point, exceeds the maximum permitted, pipe of adequate strength, special pipe embedment, or concrete arch encasement, for the applicable loading conditions and with the concurrence of Engineer, shall be furnished and installed by and at the expense of Contractor.~~

F. Minimum Trench Widths

1. ~~Except when maximum trench width is required for certain conduits, trenches shall be excavated to the minimum trench widths indicated in the following table.~~ Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment.

   a. Nominal Pipe Size : Less than 27 in
      1) Minimum Trench Width : Pipe OD plus 24 in
      2) Clearance (minimum sidewall clearance): 12 in

   b. Nominal Pipe Size : Less than 27 in through 60 in
      1) Minimum Trench Width : Pipe OD plus nominal pipe size
      2) Clearance (minimum sidewall clearance): ID/2
      3)
      4) ID = Inside Diameter (or span) of conduit

   c. Nominal Pipe Size : Less than Greater than 60 in
      1) Minimum Trench Width : Pipe OD plus 70 in
      2) Clearance (minimum sidewall clearance): 30 in
      3)

2. Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.

3. Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits.

G. Mechanical Excavation

1. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

2. Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, and that trench alignment is such that pipe, when accurately laid to specified alignment, will be centered in the trench with adequate sidewall clearance. Undercutting the trench sidewall to obtain sidewall clearance will not be permitted.

3. ~~In locations where maximum trench widths are required for designated rigid conduits, mechanical equipment shall be operated so that uniform trench widths and vertical sidewalls are obtained at least from an elevation 12 inches above the top of the installed pipe to the bottom of the trench.~~

H. Cutting Concrete Surface Construction

1. Cuts in concrete pavement and concrete base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-1/2 inches deep along each side of the trench and along the perimeter of cuts for structures.

2. Concrete pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.

3. Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.

4. Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.

I. Excavation Below Pipe ~~Sub-grade~~

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1. Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, as indicated on Figure ~~[1-02202]~~**[**1-31 23 33**]**, to provide for the installation of granular embedment.

2. Bell holes shall provide adequate clearance for tools and methods used for installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

J. Artificial Foundations in Trenches

1. Whenever unsuitable or unstable soil conditions are encountered, Contractor shall notify Engineer immediately. When authorized by the Engineer, trenches shall be excavated below grade and the trench bottom shall be brought to grade with suitable material. In such cases, adjustments will be made in the Contract Price in accordance with the provisions of the General Conditions.

K. Over-Excavation

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1. Over-excavation carried below the ~~grade~~ trench bottom or structure, unless authorized by the Engineer, shall be backfilled to the required grade with material acceptable to the Engineer and compacted to the satisfaction of the Engineer, at no additional cost to the Owner.

3.4 PIPE EMBEDMENT

A. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on Figure ~~[1 02202]~~**[**1-31 23 33**]** and to the following supplementary requirements.

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B. Embedment material shall contain no cinders, clay lumps, or other material which may cause pipe corrosion.

C. Embedment Classes.

1. Class A Arch Encasement.

   a. When arch encasement is indicated on the Drawings, Class A arch encasement shall be used at all locations so indicated.
   b. When arch encasement is not indicated on the Drawings, Class A arch encasement is not required unless improper trenching or unexpected trench conditions require its use as determined by Engineer.
   c. Concrete and reinforcing steel for Class A arch encasement shall conform to the requirements of the Cast-in-Place Concrete and Concrete Reinforcement sections.

2. Class B Embedment.

   a. Class B bedding shall be used for all steel, ductile iron, bar-wrapped concrete, and vitrified clay pipelines, and for all other pipelines not otherwise specified.

3. Class B Special Embedment.

   a. Class B special embedment shall be used for HDPE, PVC, ABS, FRP, GRP, steel or stainless steel pipe where the process fluid design maximum temperature is 140° F or higher such as for pressurized air service, and when recommended by the pipe manufacturer.

4. Class C Embedment.

   a. Class C embedment shall be used for all reinforced concrete and prestressed concrete pipelines.

D. Embedment for Ductile Iron, Steel, FRP, and PVC Pipelines

1. Granular embedment for polyethlene tube protected ductile iron, coal tar or tape coated steel, FRP, and PVC pipelines shall be **[**pea gravel, **]**crushed rock or crushed gravel with rounded or subrounded particles. Crushed rock or gravel with sharp edges which could cause significant scratching or abrasion of the pipe or damage to the coating or polyethylene tube protection shall not be used unless otherwise approved by Engineer and all damage is repaired to the satisfaction of Engineer.

2. ~~Inundated sand may be used for granular embedment in locations where the use of water will cause no damage to adjacent property and where it can be placed and properly compacted without damage to the pipe.~~

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3. ~~Inundated sand for granular embedment shall be deposited in, or placed simultaneously with the application of water so that the sand is inundated during compaction. During placement, the sand shall be compacted with a mechanical probe type vibrator. Water shall be allowed to escape or shall be removed during vibration, and no ponding shall be allowed to take place. Inundated sand shall be compacted to 70 percent relative density as determined by ASTM D4253 and D4254. If the required density cannot be achieved, placement and compaction methods shall be altered.~~

E. Placement and Compaction

1. Granular Embedment

a. Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

b. After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof by shovel slicing or other suitable methods to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

c. Placing and compaction of embedment material shall not damage the pipe coating or polyethylene encasement. Embedment material shall not be dumped directly on the pipe or polyethylene encasement unless a suitable temporary isolation layer such as a 60 mil HDPE sheeting, is used to cover the pipe and polyethylene encasement.

d. Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

e. Granular embedment shall be placed in layers not more than 6 inches deep and compacted as specified.

f. Each lift of granular embedment material shall be vibrated with a mechanical probe type vibrator or shovel sliced during placement to ensure that all spaces beneath the pipe are filled. Granular embedment shall be placed in maximum lift thickness of 6 inches and compacted. Each lift of embedment material shall be compacted with three passes (round trip) of a platform type vibrating compactor and to at least 70 percent relative density as determined by ASTM D4253 and D4254.

g. Where indicated on the Drawings or where silt, fine sand, or soft clay soils are encountered below groundwater, migration of soil into the embedment material shall be prevented by installing filter fabric Type A, or by using ~~graded gravel~~ in place of granular embedment. Filter fabric shall be placed on the trench surfaces so that it completely surrounds the embedment material. Joints shall be lapped 12 inches .

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h. Unless otherwise indicated on the Drawings, where pipes pass through water-containing embankments, granular embedment material shall be omitted and the trench bottom shall be graded to provide uniform and continuous support for the pipe. The pipe shall be embedded in embankment material contaning no rocks or stones. The embedment material shall be compacted to the same density as the existing embankment or to at least 95 percent relative compaction in accordance with ASTM D698, whichever is higher.

2. Compacted Embedment

a. Compacted embedment shall be placed in uniform layers not more than 8 inches thick and compacted to not less than **[**95% maximum density as determined by ASTM D698**][**Alternate compaction requirement **]**.

b. Where Class C embedment is required, compacted embedment shall be placed to the top of the pipe in all areas where compacted trench backfill is specified and around restrained pipe sections. Placing and compaction of embedment shall not damage the pipe or coating.

3. Hand Placed Embedment

a. Hand placed embedment shall be placed by hand shovels or using methods that prevent dropping the material for more than 24 inches above the pipe. Hand placed embedment shall be lightly tamped using hand equipment. Care shall be taken so as to not damage the pipe or coating.

F. Groundwater Barrier

1. Continuity of embedment material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Groundwater barriers for sewer lines that contain manholes with cast-in-place bases shall be compacted soil around each manhole, extending through any granular material beneath the manhole, and meeting ASTM D2487 soil classification GC, SC, CL, or ML-CL and shall be compacted to at least 95 percent of maximum density with moisture content within 2 percent of the optimum moisture content (ASTM D698). Material may be finely divided, suitable job excavated material, free from stones, organic matter, and debris.

2. Groundwater barriers for sewer lines that contain manholes with precast (developed) bases and for all other pipelines shall be soil plugs of 3 feet in width, extending the full depth and width of granular material, and spaced not more than 400 feet apart. The soil plugs shall be constructed from soil meeting ASTM D2487 classification GC, SC, CL, or ML, and compacted to 95 percent of maximum density at near the optimum moisture content (ASTM D698).

3.5 TRENCH BACKFILL

A. All trench backfill above pipe embedment shall conform to the following requirements.

B. A layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete thrust blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.

C. Compacted Backfill

1. Compacted backfill will be required for the full depth of the trench above the embedment in all ~~the following~~ locations:

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~~a. Where beneath pavements, surfacings, driveways, curbs, gutters, walks, or other surface construction or structures.~~
~~b. Where in street, road, or highway shoulders.~~
~~c. In established lawn areas.~~

2. The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than that which is underlying adjoining lawn areas.

3. Trench backfill material shall be **[**suitable job excavated material**]**~~**[**inundated sand**]**~~**[**~~or~~ **[**graded gravel**]**~~**[**Indicate alternative materials and locations**]**~~ and shall be as specified herein.

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4. Job Excavated Material

a. Job excavated materials shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Each layer of material shall have the best possible moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as needed and thoroughly mixed to ensure uniform moisture content and adequate compaction. Increased layer thickness may be permitted for noncohesive material if Contractor demonstrates to the satisfaction of Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Job excavated material shall be compacted to 95 percent of maximum density at a moisture content **[**within 2 percent of the optimum moisture content for granular soil and within 3 percent of the optimum moistujre content for cohesive soil**][]** as determined by **[**ASTM D698**][]**.

~~5.~~ Crushed Rock~~Graded Gravel~~

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a. ~~Gravel~~Crushed rock trench backfill shall be deposited in uniform layers not exceeding 12 inches in uncompacted thickness. The backfill shall be compacted with a suitable vibratory roller or platform vibrator to at least 70 percent relative density as determined by ASTM D4253 and D4254.
b. Groundwater barriers specified under pipe embedment shall extend to the top of the ~~graded gravel~~ crushed rock backfill.

D. Ordinary Backfill [Not used]

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~~1. Compaction of trench backfill above pipe embedment in locations other than those specified will not be required except to the extent necessary to prevent future settlement. Contractor shall be responsible for backfill settlement as specified.~~

~~2. Ordinary earth backfill material to be placed above embedments shall be free of brush, roots more than 2 inches in diameter, debris, cinders, and any corrosive material, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth.~~

~~3. Backfill material above embedments shall be placed by methods which will not impose excessive concentrated or unbalanced loads, shock, or impact on installed pipe, and which will not result in displacement of the pipe.~~

~~4. Compact masses of stiff clay or other consolidated material more than 1 cubic foot in volume shall not be permitted to fall more than 5 feet into the trench, unless cushioned by at least 2 feet] of loose backfill above pipe embedment.~~

~~5. No trench backfill material containing rocks or rock excavation detritus shall be placed in the upper 18 inches of the trench, nor shall any stone larger than 8 inches in its greatest dimension be placed within 3 feet of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.~~

E. Water-Settled Earth Backfill

1. Settlement or consolidation of trench backfill using water jetting or ponding shall not be performed.

F. Structure Backfill

1. Backfill around manholes and small concrete vaults shall meet the requirements specified for **[][**structure backfill specified in the Excavation and Fill for Structures section**][]**.

G. Controlled Low Strength Material (CLSM) shall be as specified in the Excavation and Fill for Structures specification section.

3.6 DRAINAGE MAINTENANCE

A. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed, and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3.7 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES

A. Where trenches are constructed in ditches or other watercourses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, or as otherwise required, ditch checks shall be installed. Unless otherwise indicated on the Drawings, ditch checks shall be concrete. Ditch checks shall extend at least 2 feet below the original ditch or watercourse bottom for the full bottom width and at least 18 inches into the side slopes, and shall be at least 12 inches thick.

3.8 FINAL GRADING AND PLACEMENT OF TOPSOIL

A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches . Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Topsoil required to provide the minimum thickness shall be imported and placed at no additional cost to the Owner.

B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3.9 DISPOSAL OF EXCESS EXCAVATED MATERIALS

A. Disposal of excess material from ~~trench excavations on plant and major facility construction sites~~ within the wastewater treatment plant site limits shall be accomplished as specified in the Excavation and Fill for Structures section of the Specifications for the major construction.

B. Disposal of excess material from **[]**trench excavation sites shall be as follows. Except as otherwise permitted, all excess excavated materials shall be disposed of away from the Site.

C. Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be installed in trench backfill, debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site.

D. Excess earth from excavations located in unimproved property may be distributed directly over the pipe trench and within the pipeline right-of-way to a maximum depth of 6 inches above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus wasted shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be allowed where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess

excavated materials, including hauling, handling, grading, and surfacing, shall be a subsidiary obligation of Contractor and no separate payment will be made therefore.

3.10 SETTLEMENT

A. Contractor shall be responsible for all settlement of trench backfill which may occur within the correction period stipulated in the General Conditions.

B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

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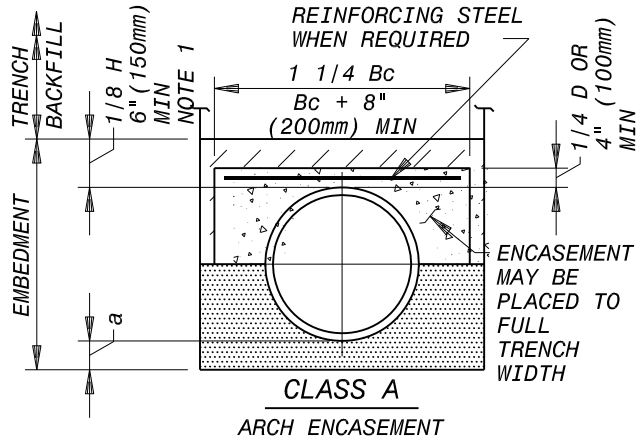
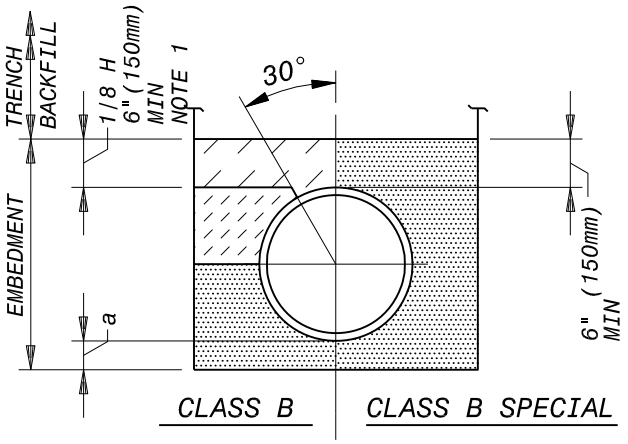




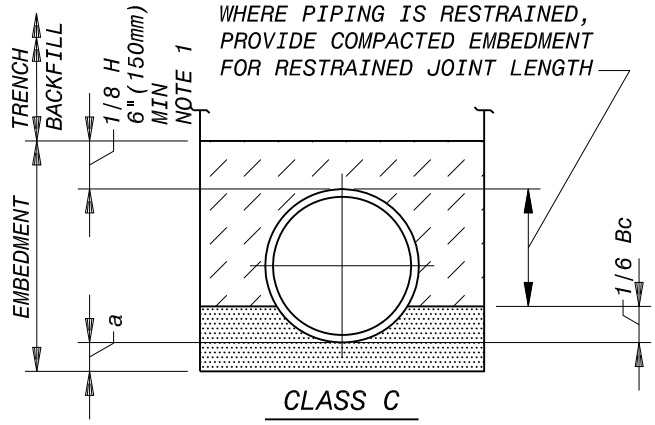


TABLE OF EMBEDMENT DEPTHS BELOW PIPE

D	a MIN SOIL		a MIN ROCK	
	in	mm	in	mm
27"(675 mm) & SMALLER	3	75	6	150
30"(750 mm) TO 60"(1500 mm)	4	100	9	225
66"(1650 mm) & LARGER	6	150	12	300

NOTES:

1. EMBEDMENT ABOVE THE TOP OF THE PIPE SHALL BE AN UNCOMPACTED LAYER FOR ALL INSTALLATIONS.
2. REFER TO SPECIFICATIONS FOR GEOTECHNICAL FABRIC OR SPECIAL EMBEDMENT REQUIREMENTS FOR TRENCHES IN FINE SOILS EXTENDING BELOW GROUNDWATER LEVEL.
3. TRENCH OUTLINES DO NOT INDICATE ACTUAL TRENCH EXCAVATION SHAPE, SOIL CONDITIONS, OR PRESENCE OF SHEETING LEFT IN PLACE. EMBEDMENT MATERIAL SHALL EXTEND THE FULL WIDTH OF THE ACTUAL TRENCH EXCAVATION.
4. FOR RESTRAINED JOINT PIPE LENGTH WITH CLASS C EMBEDMENT THE BACKFILL ABOVE THE GRANULAR EMBEDMENT AND BELOW THE TOP OF THE PIPE SHALL BE COMPACTED EMBEDMENT.

LEGEND

Bc	OUTSIDE DIAMETER OF PIPE
H	COVER ABOVE TOP OF PIPE
D	NOMINAL PIPE SIZE
a	EMBEDMENT BELOW PIPE (SEE TABLE)

HAND PLACED EMBEDMENT *

COMPACTED EMBEDMENT *

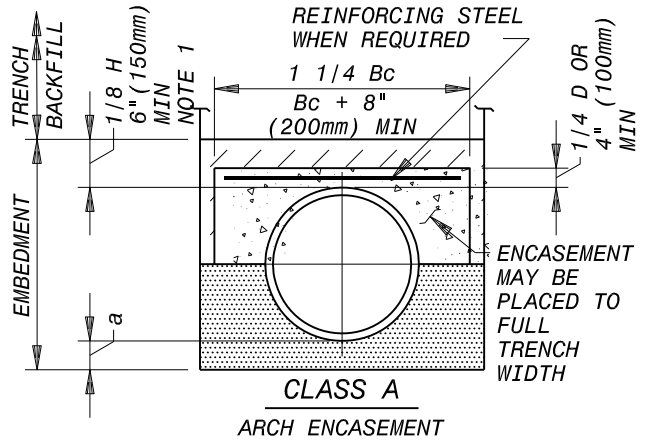
GRANULAR EMBEDMENT

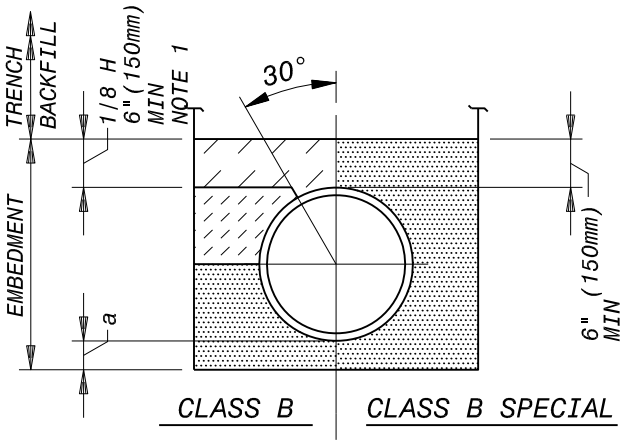
CONCRETE

* OR GRANULAR EMBEDMENT

EMBEDMENTS FOR CONDUITS

BLACK & VEATCH	TRENCHING AND BACKFILLING	FIG 1-02202





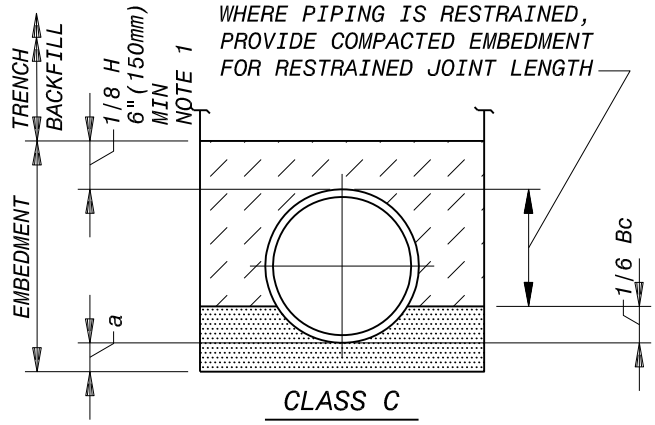


TABLE OF EMBEDMENT DEPTHS BELOW PIPE

D	a MIN SOIL		a MIN ROCK	
	in	mm	in	mm
27"(675 mm) & SMALLER	3	75	6	150
30"(750 mm) TO 60"(1500 mm)	4	100	9	225
66"(1650 mm) & LARGER	6	150	12	300

NOTES:

1. EMBEDMENT ABOVE THE TOP OF THE PIPE SHALL BE AN UNCOMPACTED LAYER FOR ALL INSTALLATIONS.
2. REFER TO SPECIFICATIONS FOR GEOTECHNICAL FABRIC OR SPECIAL EMBEDMENT REQUIREMENTS FOR TRENCHES IN FINE SOILS EXTENDING BELOW GROUNDWATER LEVEL.
3. TRENCH OUTLINES DO NOT INDICATE ACTUAL TRENCH EXCAVATION SHAPE, SOIL CONDITIONS, OR PRESENCE OF SHEETING LEFT IN PLACE. EMBEDMENT MATERIAL SHALL EXTEND THE FULL WIDTH OF THE ACTUAL TRENCH EXCAVATION.
4. FOR RESTRAINED JOINT PIPE LENGTH WITH CLASS C EMBEDMENT THE BACKFILL ABOVE THE GRANULAR EMBEDMENT AND BELOW THE TOP OF THE PIPE SHALL BE COMPACTED EMBEDMENT.

LEGEND

Bc OUTSIDE DIAMETER OF PIPE
H COVER ABOVE TOP OF PIPE
D NOMINAL PIPE SIZE
a EMBEDMENT BELOW PIPE (SEE TABLE)

HAND PLACED EMBEDMENT *

COMPACTED EMBEDMENT *

GRANULAR EMBEDMENT

CONCRETE

* OR GRANULAR EMBEDMENT

EMBEDMENTS FOR CONDUITS

BLACK & VEATCH	TRENCHING AND BACKFILLING	FIG 1-31 23 33

TEMPORARY EARTH RETENTION SYSTEM
DESIGN CERTIFICATE – 2

I, the undersigned professional engineer licensed in Alabama, hereby certify that the temporary earth retention system (as defined in Section 31 23 33) for _____(trench location) has been designed by me, and is in compliance with the Contract Documents.

Name: _____ Alabama P.E. Number: _____

Signature: _____

Date: _____

_____
(Seal)

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Schedule [02202][31 23 33]-S01

Maximum Trench Width Schedule

1.000	General
1.010	Specification Section **[**02202**][**31 23 33**]**
2.000	Requirements

Pipe Designation	Nominal Pipe Size		Maximum Trench Width		Minimum Sidewall Clearance	
	in.	mm	in.	mm	in.	mm
Water Line	12		57		12	
Outfall Sewer	24		72		12	
Water Line	2		38		12	
Water Line	6		50		12	

End of Section

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Section 31 37 00 - RIPRAP

PART 1 – GENERAL

1-1. SCOPE. This section covers the material and construction requirements for rock riprap slope protection, including subgrade preparation and the handling, placing, and finishing of the riprap slope protection. Riprap slope protection shall be placed where indicated on the ~~Contract~~ Drawings ~~and as directed by the Engineer~~.

1-2. SUBMITTALS. All submittals of data shall be in accordance with the submittals section.

1-2.01. Test Reports and Samples. Suitable test reports shall be submitted for use in determining the acceptability of the riprap source and materials. The source used ~~to be utilized~~ shall have been tested within 6 months prior to use under this contract, in accordance with the testing specified in the Quality Assurance paragraph. The approval of a source shall not be construed as approval of all materials from that source, and materials from certain areas or channels within the approval source may be rejected. The acceptability of the stone shall be subject to the final approval of the Engineer at the work site. In the event suitable test reports are not available, representative riprap samples shall be tested and submitted for acceptance. Materials shall be subjected to all of the tests listed herein, and other tests considered necessary by the Engineer to determine the durability and quality of the materials.

Riprap granular filter material shall meet all the quality and test requirements specified for riprap.

1-3. QUALITY ASSURANCE. The materials used for riprap and riprap granular filter shall meet the following minimum test standards.

1-3.01. Specific Gravity. The specific gravity (bulk saturated surface dry) shall be a minimum of 2.50 by ASTM C127.

1-3.02. Soundness. The material shall not lose more than 15 percent of its weight during a sodium sulfate test after 5 cycles as determined by ASTM C88 (2-1/2 to 1-1/2 inch sample).

1-3.03. Wear. The material shall not lose more than 50 percent of its weight during an abrasion test (Grading A) after 500 cycles as determined by ASTM C131.

1-3.04 Gradation. The material shall meet the gradation requirements for gradation specified herein under Materials.

Source: The source proposed for quarrying shall be designated not less than 14 days before placing any riprap. No materials shall be used until review of the designated source and testing of the materials is complete.

Control of gradation at the work site will be by visual inspection. The Contractor shall provide a sample of stone of at least 10 tons, meeting the gradation for each class of riprap and granular filter specified. A sample of each class shall be located at the work site near the location where the riprap is to be placed as directed by the Engineer. The sample shall be used as a frequent reference for judging the gradation of the riprap and granular filter supplied and shall be in place and acceptable before riprap placing work begins.

Any difference of opinion between the Engineer and the Contractor concerning gradation shall be resolved by dumping and checking the gradation of two random truckloads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2-1. MATERIALS. Stone used for riprap shall be broken, quarry-run durable natural stone from a single quarry source. Riprap shall meet the gradation requirements specified below and shall be hard, durable, angular in shape; resistant to weathering and to water action; free from overburden, spoil, shale, organic material, and other unsuitable materials. Recycled concrete material will not be accepted for riprap material.

All stone shall be reasonably well graded from the smallest to the maximum size specified. Soil, sand and fines less than one-half inch in maximum dimension shall not be permitted in an amount exceeding 5 per cent by weight.

Stone for riprap shall be blocky in shape. Flat, thin, elongated, and slab shaped stone will not be accepted. Not more than 25 percent of the stone distributed throughout the gradation shall have a length more than 2.5 times the breadth or thickness. No stone shall have a length exceeding 3.0 times its breadth or thickness.

The riprap layer shall consist of materials meeting the gradation indicated below.

2-1.01. Quarry stone Riprap. Quarry stone riprap shall have a D_{50} stone size with gradations as follows:

Riprap Gradation – 12" (D_{50})	
Maximum % of Riprap Smaller Than Given Size by Weight	Intermediate Rock Dimension (inches)
10	6
50	12
90	18
Maximum Rock Dimension: 24 inches	

2-1.02. Riprap Granular Filter. Riprap granular filter material shall meet all the quality and test requirements specified for riprap above. Riprap filter material shall have a D_{50} stone size with gradations as follows:

Riprap Filter for 12" Riprap	
% of Gradation Smaller Than	Size (inches)
85	1.4 (min)
50	0.3 (min)
15	0.2 (min) to 1.3 (max)

Riprap granular filter shall not contain any organic materials or shale. Gradation of all riprap granular filter material shall be determined by ASTM C136 and C117. All parts on individual grading curves plotted for representative samples of filter material shall be within the specified boundary limits defined by smooth curves plotted on a mechanical analysis diagram. The individual grading curves within these limits shall not exhibit abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities.

2-1.03. Filter Fabric Filter fabric shall be Type B fabric as specified in Excavation and Fill for Structures section.

PART 3 – EXECUTION.

3-1. INSTALLATION.

3-1.01. Subgrade Preparation. Subgrade surfaces on which the riprap slope protection is to be placed shall be cut or filled, graded, and compacted as specified in the earthwork section to the lines and grades indicated on the Contract Drawings and as necessary to provide a firm, stable, smooth, and even surface. All sharp objects, large stones, and stumps shall be removed.

3-1.02. Riprap, Riprap Granular Filter and Filter Fabric Placement. The riprap, riprap granular filter and filter fabric shall be placed as specified herein and as indicated on the ~~Contract~~ Drawings. Sufficient material shall be excavated from the slope to accommodate the full specified thickness of riprap and filter.

Filter fabric shall be installed under all riprap granular filter. Riprap and granular filter shall be carefully placed so as to prevent damage to filter fabric. The riprap granular filter blanket shall be placed to the full specified thickness of the filter in one operation, using methods which will not cause segregation of particle sizes within the bedding. Where the trimmed slope is below the allowable minus tolerance limit, the slope shall be brought to grade by filling with granular filter material at the expense of the Contractor with no allowable unit adjustment. The surface of the finished layer shall be uniform and free from mounds or windrows.

Stone for riprap shall be placed in a manner which will produce a mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed in conformance with the lines, grades, and thicknesses indicated on the ~~Contract~~ Drawings and as specified herein. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

The larger stones shall be well distributed and the entire mass of stone shall conform to the gradation specified. All material placed as riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

A tolerance of ±6 inches from the slope lines and grades indicated on the ~~Contract~~ Drawings will be allowed in the finished surface of the riprap except that either extreme of such tolerance shall not be continuous over an area greater than 100 square feet.

All riprap placement shall be performed in the dry unless otherwise approved by Engineer. Any placement of riprap and/or bedding in water shall be placed at depths double what is shown on ~~Contract~~ Drawings. In addition, riprap shall not be allowed to freefall when placing below the water level. The riprap shall be placed with clam shell,

backhoe bucket, or other methods. The clam shell or backhoe bucket shall be lowered to within 3 feet or less of the excavation bottom or ~~rockfill~~ bedding or riprap surface before placing. 1

3-2. MAINTENANCE. The Contractor shall maintain the riprap in good condition until all work is completed and accepted by the Owner. Maintenance shall include immediate repairs of any defects that may occur. Faulty work shall be replaced by and at the expense of the Contractor for the full depth of the layer.

End of Section

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SECTION 31 52 00 - COFFERDAMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers materials, design, and construction of cofferdams.

B. This section is applicable to the following facilities:

1. Outfall structure at Tennessee River.
2. Pipe installation in berm between the Influent and Polishing Ponds.
3. 24” DIP effluent line from Chlorine Contact Basin to Polishing Ponds.
4. Outfall pipe crossing of creek at approximately Station 16 +00.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed professional engineer, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data

1. Data covering the proposed cofferdams shall be submitted in accordance with the Submittals Procedures section and this specification.

B. Certifications.

1. Before starting construction on the cofferdam, the Contractor shall ensure that the cofferdam design engineer shall complete and submit to Engineer the Cofferdam Design Certificate (Figure 31 52 00) and the Contractor shall use the cofferdam design. The design values shall be included in the Cofferdam Design Certificate. A separate certificate shall be submitted for each unique cofferdam design. The certificate shall be signed and sealed by a licensed professional engineer in Alabama.

1.4 INSURANCE

A. Professional Liability insurance shall be provided as specified in the Supplementary Conditions.

PART 2 - PRODUCTS

2.1 DESIGN

A. Contractor shall assume all responsibility for the stability and adequacy of cofferdams erected by Contractor and all costs and damages resulting from any failure thereof.

B. The cofferdam design shall provide for adequate working space, watertightness, and a suitable dewatering system.

C. Steel used in the construction of the cofferdam shall be designed in accordance with the American Institute of Steel Construction standards.

D. No fill shall be placed as part of cofferdam construction.

E. Required limiting values for critical design criteria are listed on the Cofferdam Design Certificate. Contractor shall use higher elevations if higher water and/or earth levels are likely on the cofferdam exterior or shall use higher loading if construction operations will impose higher loads. Materials need not be new, but all materials shall be undamaged and free from defects which impair the strength or suitability. The analysis and design shall be in general accordance with the procedures described in Earth Retention Systems Handbook by Alan Macnab, McGraw-Hill, 2002 (Macnab) or the latest edition of Sheet Pile Design by Pile Buck, Harry A. Lindahl, and Don C. Warrington (Pile Buck) or other industry accepted procedures, if such procedures will produce a more conservative design.

2.2 COFFERDAM PERMITS

1 ~~A.~~ Necessary permits for the work to be performed under the jurisdiction of the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers have been ~~secured~~ applied for. Copies of the permits ~~are bound as an appendix to these specifications~~ will be provided and the draft/final permit provided to the contractor when obtained. It ~~may also~~ will be necessary for Contractor to ~~inform the Tennessee Valley Authority (TVA) as to the scope and nature of the work and the time of construction, and to provide additional data on cofferdam design and construction~~ confirm construction methodology and potential impacts as compared to the applicable permits that were obtained and inform TVA/USACE, or make adjustments to the permits, as necessary as to the scope and nature of the work and the time of construction, and to provide additional data on the specific design and construction should it differ. ~~Contractor will be notified regarding submittal of the necessary data to TVA.~~

2.3 COFFERDAM DESIGN ENGINEER

A. The cofferdam design engineer shall be licensed in Alabama. The cofferdam design engineer shall sign and seal the cofferdam construction drawings.

PART 3 - EXECUTION

3.1 DEWATERING

A. The water level within each cofferdam shall be continuously maintained at a level which will provide a stable subgrade until completion of the base slab. Structural concrete shall not be placed in water. The dewatering system shall prevent the loss of foundation material and shall have reliable standby equipment and power supply. Dewatering shall comply with requirements of specification Section 31 23 19 – Dewatering.

B. After completion of the base slab, the water level within the cofferdam shall be continuously maintained, by the dewatering system, at a level that prevents flotation of the structure. In addition to the dewatering system, an alternative failsafe method shall be provided to prevent flotation of the structure if the primary dewatering system fails.

3.2 REMOVAL

A. The cofferdam and all temporary construction shall be removed after completion of permanent construction. Removal of cofferdams constructed in water shall be complete, including all sheet piling, struts, braces, and other structural members.

3.3 BLASTING

A. Blasting shall be permitted. Contractor shall be responsible for any damage caused by blasting operations and shall comply with the blasting requirements specification Section - Excavation and Fill for Structures.

B. Excavated rock which cannot be handled and compacted as fill in accordance with specification Section 31 23 11 - Excavation and Fill for Structures, shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials.

1

End of Section

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COFFERDAM DESIGN CERTIFICATE

The undersigned engineer certifies that the cofferdam design for _____ (structure and location) complies with the Contract Documents and the following requirements:

	Limiting Value	Design Value
1. Design elevation of earth around the cofferdam	(Note d)	_____
2. Minimum design elevation of water or groundwater around the cofferdam (Note a)	(Note a)	_____
3. Bottom of excavation, elevation	__Note d)___	_____
4. Minimum factor of safety against bottom heave or sand boiling	1.5	_____
5. ASTM designation and grade of steel	(Note b)	_____
6. Unit stress		
Tension	(Note c)	_____
Shear	(Note c)	_____
Compression	(Note c)	_____
Combined axial and bending	(Note c)	_____
Buckling	(Note c)	_____

Notes:

1 (a) Design elevation for cofferdam for outfall structure shall be EL. ~~600.44~~609.8, which is based on ~~5 feet above normal river level~~FEMA, 10-year elevation ~609.8'; design elevation for pipe installation in berm between the Influent and Polishing Ponds and Treated DIP is EL. 630.0. which is ~1.0' higher than the EL. 629.05 (4 MGD) level in Influent Pond; and 3 feet above creek bank at outfall pipe crossing.

(b) Structural steel grades in accordance with AISC. Sheet piling shall be ASTM A572.

(c) Allowable unit stresses in accordance with AISC. No increase in stresses due to temporary loads. No overstress permitted for any reason.

(d) Per Drawings.

Certified by:

Name _____ Alabama P.E. Number_____

Signature _____ _____

Date _____

(Seal)

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SECTION 31 75 00

SHAFT EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section covers the requirements for design of the shaft excavation support systems. The Contractor shall have sole responsibility for sizing the shaft subject to the requirements included herein and the Drawings. Excavation support at the shaft shall consist of shoring and bottom shaft designed and constructed in accordance with this Section. Contractor is granted full discretion to select any of the allowed methods of shaft support, subject to review by the ENGINEER.

1.2 RELATED SECTIONS

A. Related Sections include, but are not necessarily limited to the following:

1. Division 00 – Procurement and Contracting Requirements
2. Division 01 – General Requirements
3. 31 09 13 Geotechnical Instrumentation and Monitoring
4. Section 31 23 19 - Dewatering
5. Section 31 23 33 – Trenching and Backfilling
6. Section 31 73 00 – Contact Grouting

1.3 REFERENCE CODES AND STANDARDS

A. Commercial Standards include, but are not necessarily limited to the following:

1. AISC Steel Construction Manual
2. ASTM A82 - Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
3. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric for Concrete Reinforcement.

4. ASTM A283 - Standard Specifications for Low and Intermediate Tensile Strength Carbon Steel Plates.

5. ASTM A307 - Standard Specifications for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

6. ASTM A496 - Standard Specifications for Steel Wire, Deformed, for Concrete Reinforcement.

7. ASTM A615 - Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

8. ASTM C33 - Standard Specification for Concrete Aggregates.

9. ASTM C150 - Standard Specifications for Portland Cement.

10. ASTM A1011 - Standard Specification for light gauge Hot-Rolled Sheet and Strip Carbon

11. OSHA Standard 29 CFR Part 1926 – Safety and Health Regulations for Construction

1.4 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for Shaft Excavation Support and Protection, including shaft dewatering, temporary staging site fencing and gates, and temporary facilities and controls, shall be paid as a Lump Sum basis that shall include all items specified in this section unless payment is specified otherwise in this section.

2. Refer to Section 01 29 00 - Measurement and Payment for unit price procedures.

1.5 DEFINITIONS

A. Shaft: For the purpose of this Section, the term “shaft” shall mean the excavation required to facilitate tunnel construction, manhole structure installation and sewer connections.

B. Support: General term for the materials installed to retain and stabilize the ground around a shaft excavation.

C. Ground water control system: System used to dewaterand depressurize water-bearing soil layers.

D. Steel Set or Steel Rib: Structural steel member curved to match the theoretical shape of the shaft excavation and uniformly blocked or expanded to the excavated surface.

E. Liner Plate: Cold stamped steel plate segments that are bolted together to form an initial support for both shafts and tunnels. Liner plates can use two or four flanged connections and can include gasketed connections if specified.

F. Shield: Fabricated ground support, circular in section, providing 360 degree protection to workers inside the shield. The shield will have a cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered. Initial support involves directly jacking the carrier pipe or is erected within a tail section attached to the shield.

1.6 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design shaft excavation support systems and working slabs to withstand earth pressures, hydrostatic pressures, bottom heave, equipment loads, applicable construction loads, and other surcharge loads to allow the safe construction of the tunnel without movement or settlement of the ground, and to prevent damage to, or movement of, adjacent existing structures, streets, and utilities.

2. Design entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by Contractor's professional engineer. Shaft must withstand full hydrostatic head without failure.

3. Design excavation support systems to be compatible with the subsurface ground conditions at the Site~~presented in the Geotechnical Data Report (GDR) in accordance with AISC and ACI code provisions, as applicable. Shaft excavations will extend below the groundwater table.~~ The Contractor shall be responsible for the cutoff of groundwater flows as necessary to construct the selected support system and maintain a stable excavation.

4. Design each member or support element to support the maximum loads that can occur during construction with appropriate safety factors.

5. Design the support systems to minimize horizontal and vertical movements, and to protect adjacent properties, facilities, and utilities from damage. Design support systems to maintain the stability of the excavation against sliding and bottom heave.

6. Employ wales, struts, and beams for bracing and lateral support as required. Provide struts with intermediate vertical and horizontal supports as required to prevent buckling.

7. Design work slab for the bottom of excavation to provide stable support for construction operations.

8. Locate the shaft(s) to construct the trenchless segments between the stations indicated on the Drawings. In addition, the shaft locations, and geometries shall accommodate the necessary connections to existing sewers and facilitate installation of new structures (e.g., manholes).

1 9. Design of shaft excavation support systems ~~in accordance~~ shall comply with OSHA ~~requirements~~ regulations.

10. Design break-in and break-out support or ground improvement installed to transfer loads and maintain excavation support and stability of the excavation when commencing tunneling and when holing through to the exit shaft. Launch seals may be used to prevent groundwater entry around the tunnel excavation before breaking out or in.

11. Mandatory dewatering prior to excavation is required for all shaft excavation support systems. The following defines the allowed shaft excavation support systems for the trenchless construction.

    a. Steel sheet piles
    b. Grouted steel liner plates

12. The selected excavation support system and shaft geometry shall be compatible with the presence of existing sewers and other utilities within the shaft footprint. Precautions shall be taken to avoid damage to existing utilities during and after installation of the excavation support system. The excavation support system shall be designed to maintain stability of the excavation where existing utilities penetrate through the ground support system.

13. All allowed shaft excavation support systems shall conform to the requirements of Section 31 23 19 Dewatering.

14. All shafts shall have a water retaining liner extending at least 4 feet above existing ground. When shafts fall within the 100-year floodplain, design the shafts with a water retaining liner extending 2 feet above the 100-year flood elevation or 4 feet above existing grade, whichever is greater. It is acceptable when liner is stored at Job Site for immediate installation in lieu of being installed at shaft, provided that installed shaft liner extends at least 4 feet above existing ground elevation at all time.

1.7 SUBMITTALS

A. Conform to requirements of Section 01 33 00 – Submittals .

B. Shop Drawings:

1. Submit shop drawings for shaft excavation support systems, and other related information as required by these specifications. Shop drawings shall be prepared

and signed and sealed by a professional engineer licensed in the State of Alabama. At a minimum, the following information shall be submitted:

a. Name and qualifications of person responsible for the excavation support design. The plan shall be prepared and signed and sealed by a civil or structural engineer currently licensed in the State of Alabama.

b. A site plan for the shaft(s) indicating the location, excavation dimensions, site grading, microtunneling slurry separation layout, and site development details for the excavation and all work areas, and the proposed limits of disturbance surrounding each excavation.

c. Construction method to be used for the installation of each system, including sequence of installation and equipment description.

d. Submit shaft construction drawings including details of seal slabs. Clearly indicate allowable surcharge loads , including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.

e. Description of method of extending shaft above flood level in conformance with Paragraph 1.6.A.14.

f. Shop drawings and design calculations indicating arrangement of supports and construction sequence for proposed support systems. Calculations shall include estimates of likely deflections or deformations of the support system and maximum tolerable values. Provide details and supportive calculations demonstrating satisfactory safety factors against base instability.

g. Break-in and break-out plans indicating support or ground improvement installed to transfer loads and maintain excavation support and stability of the excavation when commencing tunneling and when holing through to the exit shaft. The plans shall indicate the methods to control groundwater inflow and loss of ground into the shaft when launching the MTBM, or shield, and breaking into the shaft.

h. Plans to address areas where existing sewers/utilities will penetrate shaft excavation support systems. ~~These plans shall illustrate the sequencing of excavation and excavation support installation in proximity to existing utilities, and methods to transfer loads and maintain excavation support and stability over the course of construction. In addition, the~~ The plans shall indicate methods to control groundwater inflow and loss of ground into the shaft at utility penetrations. Methods to protect existing utilities shall be included within the plans.

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i. Copies of manufacturer's data or other tabulated data if protective system(s) are designed on the basis of such data.

j. Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

k. Quality control procedures. Address material’s testing requirements and excavation monitoring provisions.

C. Shaft Excavation Work Plan: The Shaft Excavation Work Plan shall include: Shop and working drawings describing all materials the Contractor proposes to use and the method of construction and excavation intended in his performance of the Work required herein, and shall include, but not be limited to, detailed drawings, with all pertinent descriptions, technical data, performance data, and calculations of the following.

1. The Shaft Excavation Work Plan shall be submitted prior to commencing shaft excavation activities.

2. Description of ~~Job Ste~~Site security arrangements as required herein.

3. Methods and equipment proposed for use for the excavation of the shaft and for the removal of excavated materials from the shaft.

4. Shaft dimensions, design criteria, details for the initial support system, such as ring beams and lagging, ring beams and liner plates, , shoring, bracing, stabilization and protection of the excavation, and allowable surcharge loads and any restrictions on surcharge capacity, including live loads, shall be clearly shown on the shaft construction drawings. Thrust blocks, headwalls, or other reactions required for pipe jacking shall be shown, if applicable.

5. All other proposed equipment, facilities, and methods of construction, including access and egress, hoisting and/or elevators, and any other pertinent details, such as groundwater control methods, ventilation, air monitoring, lighting, communication system, cuts, ramps, and breakouts, and temporary supports for other excavations and structures adjacent to the shaft.

6. Any geotechnical boring logs from borings performed by the Contractor for whatever purpose connected to the work, including those from the installation of geotechnical instrumentation.

7. Shaft Flooding Prevention Plan that describes how the Contractor will protect the shaft.

8. Detailed drawings of shaft ladder if used.

D. Qualifications of all Contractor personnel identified in Paragraph 1.09 herein.

E. Site drainage and groundwater control shall be submitted in accordance with Section 31 23 19 – Dewatering.

F. Monitoring data shall be submitted in accordance with Section 31 09 13 Geotechnical Instrumentation and Monitoring.

G. Identify specific type of submittal and list of submittals (i.e., samples, manufacturer's certificate, etc.).

H. Shaft Excavation Shift Reports: Separate shift reports are required for each shift, which describe each activity that took place, regardless of the amount of progress. The Contractor shall submit the shift reports to the ENGINEER no later than twenty-four (24) hours after the end of each shift. The shaft excavation shift reports shall include the following information, at a minimum:

1. Number and classification of crew members, equipment, materials, and any other resources used.

2. Excavation progress during the shift: beginning and ending time and elevation of the shaft for each major division of work, volume of excavation, air monitoring readings, as well as including, but not limited to:

   a. Non-scheduled downtime, including the reason, duration, and tabulation of all impacted operations
   b. Any activity impacting but not necessarily halting production or ancillary work. Identify the nature of such activity, the impacted operations, the length of time affected, the degree of impact, and steps taken or to be taken to eliminate or mitigate future occurrences of such activities.
   c. Quantity and location of water inflows.

1.8 QUALITY ASSURANCE

A. Provide quality control testing and inspection as required by the Contractor's design engineer and in accordance with approved submittals. The Contractor's design engineer shall visit the ~~Job~~ Site to observe the work in progress on at least a weekly basis or more frequently if required by the ENGINEER.

B. Preconstruction Meetings: Contractor shall schedule and conduct a preconstruction meeting with the ENGINEER and OWNER at least seven (7) calendar days prior but not more than thirty (30) calendar days prior to commencing shaft excavation activities. The CONTRACTOR shall provide a minimum of seven (7) calendar days advance notification of meeting date and time to the ENGINEER and OWNER.

C. The following shall be reviewed and discussed at the meeting:

1. Overview of construction methods and constraints, including but not limited to working hour constraints.

2. Equipment operating parameters.

3. Safety procedures.

4. Quality control procedures and requirements and quality assurance requirements.

5. Spoil handling and transportation.

6. Reporting requirements.

7. Other issues as may be raised by the ENGINEER, OWNER, or CONTRACTOR.

1.9 QUALIFICATIONS

A. Excavation support systems shall be designed by a civil or structural engineer licensed in the State of Texas who has a minimum of ten (10) years' experience in the design of temporary earth retention.

B. All shaft excavation operations shall be managed by a project manager with at least ten (10) years of recent on-the-job management experience on similar projects, involving shafts of similar size constructed by similar methods. All shaft excavation operations shall be performed under the direction of an experienced project superintendent with at least ten (10) years of recent on-the-job management experience on similar projects, involving shafts of similar size constructed by similar methods.

C. All shaft excavation operations shall be performed under the supervision of experienced shift foremen with at least five (5) years of recent on-the-job supervision experience on similar projects, involving shafts of similar size constructed by similar methods.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Construction materials (new or used) used for the supporting systems shall be sound and free from defects that may impair their strength.

B. Structural steel: Conform to ASTM A36, or better, unless otherwise approved.

C. Timber for lagging, lagging, blocking, cribbing, or other parts of initial support shall be sound hardwood of rectangular cross section.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for the protection of all utilities encountered during the Work of this Contract. The known utilities are shown on the Drawings and the Contractor shall take every precaution when working near utilities to locate and protect such utilities from damage. All damage to, or resulting from, damage to an existing utility, whether such utility is shown or not on the Drawings shall be the sole responsibility of the Contractor and the Contractor shall replace, repair, remedy, and/or

compensate for all damages to the utility to the appropriate party at no additional cost to the OWNER.

B. Shaft excavation and the installation of the ~~initial~~ support system shall be carried out in ~~such~~ a manner ~~as to provide adequate support at all times to all~~ that protects surrounding structures. The ~~initial~~ support system shall provide a safe working and construction area, and all Work shall be performed in full conformity with the Contract Documents ~~and shall be subject to inspection by the ENGINEER. If and when required, and to the degree necessary, the Contractor's shall provide supplemental elements of initial support to maintain the safety of the shaft excavation.~~

C. The Contractor shall be responsible for protecting shafts from flooding due to infiltration, surface water, and flooding.

D. Clean and organized working conditions shall be maintained in the shaft at all times. Contractor shall immediately remove from shaft and dispose of muck, grout, spillage, and other materials wasted during the course of performing the work.

E. Observe applicable municipal, county, State, and Federal ordinances, codes, regulations, and laws.

F. Periodically examine and monitor the ground support system to identify any loosening or unstable ground or loss of ground through the ground support system and excessive deformation, overstress, or weakening of the ground support system.

G. Used material shall be in good condition, not damaged or excessively pitted.

H. Timber Used for breast boards (lagging): New or used, meeting the requirements of the Authority.

I. Design steel work for , shoring, bracing, etc. in accordance with the provisions of the AISC Manual of Steel Construction. Field welding will be permitted.

J. Develop and maintain firm and uniform bearing of the ground support system against the ground, such as by expanding the ground support system against the ground, or by filling the void space between a non-expanding ground support system and the ground by contact grouting.

K. ~~Safe and satisfactory support~~The support system shall be entirely the responsibility of the CONTRACTOR. The CONTRACTOR's support system shall be designed, detailed, and signed and sealed by a professional engineer licensed in the State of Alabama.

3.2 INSTALLATION

A. Conform to the following for shaft excavation support systems:

1. Install excavation support systems in accordance with submittals, which have been reviewed by the ENGINEER. Elements of the shaft support system, including any bracing and shoring structural members, shall be installed at the locations and in the methods, sequences, and tolerances indicated in the CONTRACTOR’s shaft construction drawings and in the CONTRACTOR’s shaft excavation work plan as required herein.

2. If settlement or deflection of supports indicates that support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the Engineer at no additional cost to the OWNER.

3. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing, and shoring. Obtain approval from Contractor's professional engineer and submit to Engineer.

4. Shaft support systems shall be installed in a manner to control groundwater inflow into the excavation, to minimize the loss of soil into the excavation, to minimize ground movements outside the excavation, to maintain the stability of the excavation, and to preserve the in-situ strength of surrounding soils.

5. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by ENGINEER. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by CONTRACTOR's professional engineer.

6. Special framing, bracing, or shoring required around tunnel "eyes" or other penetrations shall be in-place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.

7. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.

8. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Section 31 73 00 Contact Grouting. Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by ENGINEER. Perform secondary or 'back grouting' as ground measurement, voids or deformation of shaft liner are detected.

9. Promptly reset, repair, or replace elements of the ground support system that settle, become misaligned, were improperly installed, or become damaged during construction.

10. Welding shall conform to the applicable provisions of ANSI/AWS D1.1.

~~11. Shaft excavation support systems shall conform to applicable OSHA excavation, trenching, and shoring standards.~~

B. Shaft Backfill:

1. The materials used for shaft backfill shall be as indicated on the Drawings~~All shafts shall be backfilled with flowable fill in accordance with Section 31 23 23.33 Flowable Fill to at least five (5) feet below ground surface unless indicated otherwise in the drawings~~.

3.3 CLEANING

A. Removal of Shaft Support Systems

1. Shoring elements, including wales, struts, and shores shall be removed from the excavation before restoration. In no case shall any shoring or excavation support elements be left in place in the top six (6) feet below the ground surface. Removal of the support system shall be performed in a manner that will not disturb or harm adjacent construction or facilities and only after backfill has been fully compacted. Voids created by the removal of the support system shall be immediately filled with lean concrete or cement grout, as approved by the ENGINEER. The support system removed from the excavation shall remain the property of the CONTRACTOR and shall be removed from the Job Site.

END OF SECTION

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SECTION 32 16 16 - CONCRETE SIDEWALK, CURB, AND GUTTER

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the construction of concrete sidewalks, curb and gutter. This section also covers the reconstruction of concrete sidewalks, curb, and gutter.

B. Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

1.2 GENERAL

A. All existing sidewalks, and curb and gutters disturbed or damaged during construction of new work, or indicated on the Drawings to be demolished and replaced shall be reconstructed to the lines, grades, and cross sections indicated on the Drawings. Damaged curbs, sidewalks and/or gutters shall be to restored to their original locations, cross sections, and style unless indicated otherwise on the Drawings.

B. Contractor shall be responsible to remove, construct, reconstruct, and adjust as necessary all existing or new manhole tops, curb and gutter, and area drainage structures to match new grades as needed.

C. Governing Standards

1. Except as otherwise specified or indicated on the Drawings, materials, equipment, details, and construction methods shall comply with the applicable Alabama DOT standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The sources of materials shall be acceptable to Engineer. Except as otherwise modified herein, materials shall conform to the requirements of the governing standards.

B. Concrete materials shall be as indicated in the Cast-in-Place Concrete section.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. As a minimum, the top 6 inches of the subgrade shall be compacted to a 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing, curb and gutter, or sidewalk materials are placed. All subgrade and surfacing shall be sloped as indicated on the Drawings, and as needed to achieve a uniform slope between new and existing surfaces. Sidewalks shall slope toward one edge.

3.2 CONCRETE SIDEWALKS

A. Concrete shall be placed, vibrated, and finished as described in the governing standards.

B. One-half inch expansion joints shall be provided where sidewalks abut a curb, structure, existing sidewalk, at changes in directions, and at intervals of not more than 40 feet . Expansion joints shall be filled to within 3/4 inch of the surface with bituminous expansion joint material, and then filled flush to the surface with self-leveling caulking in accordance with the Joint sealant section. The joint sealing compound shall be finished slightly concave, and shall not be allowed to overflow the joint.

C. Concrete sidewalks shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. A second floating at the time of initial set shall follow initial floating.

D. Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be at right angles to the length of the curb, walk, or gutter.

E. New sidewalks shall be edged to match existing sidewalks.

F. Sidewalks shall be edged using a 3 to 4 inch wide edging tool with a 1/8 inch corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be provided at right angles to the length of the walk, using a grooving tool with 1/8 inch radius and a depth of 1.2 inch . The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.

G. The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.

H. The finished concrete shall be cured and protected as stipulated in the governing standards.

3.3 CONCRETE CURB AND GUTTER

A. New concrete curb and gutter shall be as indicated on the Drawings and specified herein. Replacement concrete curb and gutter shall match the existing curb and gutter. Unless otherwise authorized by Engineer, adjacent and enclosed curbs, drainage structures, and gutters shall be placed before placement of pavement sections.

B. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and/or gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the section, being secured so that they are not moved by depositing, compacting or finishing the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.

C. Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet .

D. Contraction joints shall be a minimum of 3 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the section. These templates shall be secured so they are not moved by depositing, compacting or finishing the concrete.

E. Unless otherwise indicated on the drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch .

F. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

G. Forms

1. Forms shall be in conformance with the governing standards. All forms shall be in good condition, with not more than 1/8 inch variation in horizontal and vertical alignment for each 10 feet in length. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and consolidating the concrete. Forms shall be designed and constructed so as to permit their removal without damage to the concrete.

H. Joints

1. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards.

a. Expansion Joints. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the Curb and Gutter section, being secured so that they are not moved by depositing and compacting the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.

Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet .

b. Contraction Joints. Contraction joints shall be a minimum of 3 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the Curb section. These templates shall be secured so that they are not moved by depositing and compacting the concrete.

Unless otherwise indicated on the Drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch .

2. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

I. Finishing

1. Curb and gutter shall be finished to the shape indicated on the Drawings. After the forms have been removed, all exposed edges shall be rounded, using an edging tool with a 1/8 inch corner radius. Exposed surfaces shall be float finished and given a light broom finish applied at right angles to the curb at the time of initial set, using a horsehair broom. Mortar or dryer shall not be used to remove imperfections. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sags, twists, or warps; shall have a uniform appearance; and shall be true to the original lines, grades, and configurations indicated on the Drawings.

3.4 PROTECTION

A. In addition to the requirements for protection set forth in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.

B. Special care shall be taken to prevent bituminous materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

SECTION 32 92 21 - SEEDING AND SODDING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers seeding and sodding to be performed after backfilling and final grading are complete. All areas disturbed by construction operations shall be treated as specified herein.

B. All lawn, ditch, and street shoulder areas within street right-of-way and temporary construction easements that are damaged during the Work shall be restored, after completion of construction, to the complete satisfaction of Owner. All areas disturbed by Contractor outside the temporary construction easements shall be restored, at Contractor's expense, to the satisfaction of the property owner, except that if the temporary construction easement through the ownership is sodded all disturbed areas outside the construction easement shall also be sodded. Occupying areas outside temporary construction easements, street right-of-way, and utility easements for any purpose shall be done only with the written approval of the property owner.

1.2 GENERAL

A. Governing Standard

B. The governing standard for the seeding and sodding Work shall be Alabama Handbook for Erosion Control, latest edition.

C. Experience

1. All Work shall be performed by a licensed landscaping Contractor who is licensed in the State of Alabama.

D. Completion

1. Seeding Work shall be completed during the period of final inspection. Seeding requirements are as follows:

    a. Locations to be seeded.
        1) Areas disturbed by construction activities.
        2) Areas used during construction including laydown/staging areas where grass is found dead or damaged.

E. Sodding shall be completed during the period of final inspection. Sodding requirements are as follows:

1. Sodding may be used at the Contractor's option in lieu of seeding.

a. Contractor's option in seeding or sodding shall not constitute a cost change.

1.3 SUBMITTALS

A. Soil Test

1. Soil shall be tested to determine nutrient needs by the state Extension Service or an independent agricultural soil testing lab. Composite sample(s) shall be collected and submitted in accordance with lab instructions. Lab report and nutrient recommendations shall be provided to the Engineer.

B. Invoices and Analysis Labels

1. A copy of supplier's invoices for all seed, mulch, and fertilizer which shows the quantity by weight purchased for the project and representative labels bearing the manufacturer's or vendor's guaranteed statement of analysis shall be submitted to Engineer for review and approval to assure compliance with specified requirements for quality and application rates.

1.4 GUARANTEE

A. Seeding

1. Contractor shall guarantee a uniform stand of seeding, free of weeds to the extent practical, and acceptable to Owner.

B. Sodding

1. Contractor shall guarantee the sodding Work to the extent that all transplanted sod shall be uniform in color, leaf texture, shoot density, and reasonably free of visible imperfections at acceptance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Prior to use, all products shall be kept dry and in a weatherproof location so that their effectiveness will not be impaired.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall conform to the requirements of the Governing Standard, except where otherwise specified.

B. Starter Fertilizer

1. Fertilizer shall be a complete pelleted or granulated fertilizer. The analysis in percent by weight shall be as determined by nutrient recommendations of the soil testing submittal.

C. Seed

D. The seed species and mixture shall be per the governing standard and in accordance with the planting dates outlined in the governing standard. Sod

1. Sod shall have been planted on cultivated agricultural land and grown specifically for sod purposes and shall conform to the quality standards of Nursery Grown Sod as defined by the Turfgrass Producers International. Sod shall be free of objectionable grassy and broad leaf weeds. Sod shall be considered free of such weeds if less than five such plants are found per 100 square feet of area. The sod species shall be per the governing standard.

E. pH Adjustment

1. If laboratory soil testing indicates the need for increased soil pH the Contractor shall add agricultural lime as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer. If laboratory soil testing indicates the need for decreased soil pH the Contractor shall add agricultural sulfur, aluminum sulfate or iron sulfate as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer

F. Topsoil

1. Topsoil shall be fertile, natural soil, typical of the locality, free from stones, roots, sticks, clay, peat, weeds, and sod, and obtained from naturally well drained areas. It shall not be excessively acidic or alkaline nor contain toxic material harmful to plant growth. Stockpiled topsoil may be used but the Contractor shall furnish additional topsoil at his own expense if required.

G. Mulch

1. Mulch shall be a specially processed cellulose fiber containing no growth or germination inhibiting factors, or shall consist of straw from hay and shall include a tackifier. Mulch

for hydroseeding operation shall be a wood mulch or combination wood and paper mulch in accordance with the Governing Standard.

PART 3 - EXECUTION

3.1 GENERAL

A. Execution of seeding and sodding Work shall conform to the Governing Standard, or shall be as specified herein, whichever is the most stringent.

B. Clearing

1. Prior to finish grading, areas to be seeded or sodded shall be cleared to remove stumps, stones larger than 3 inches , roots, cable, wire, debris or other materials that might hinder seeding and/or sodding and future turf maintenance.

C. Finish Grading

1. Seeding and/or sodding shall not be started until all earthwork has been substantially completed. Backfills and fills shall be allowed to settle, the topsoil spread, and finish grading completed before the Work is started. Finish grading shall result in a surface conforming to the contours indicated on the Drawings.

D. Application of Fertilizer and pH Adjustment

1. After finish grading, any fertilizer or chemicals for pH adjustment specified shall be applied uniformly to areas to be seeded.

2. Fertilizer application rate shall be determined by analysis of soil sample(s) and as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer. Chemicals for pH adjustment shall be applied at a rate based on a soil test for pH. The rate shall be adequate to neutralize the soil.

E. Final Preparation

1. Following application of additives and/or fertilizers the areas to be seeded and/or sodded shall be tilled to a true depth of 6 inches by disking, harrowing, or other accepted methods to thoroughly incorporate the additives and fertilizer, destroy vegetation, and pulverize the soil. After tilling, the bed shall be smoothed by dragging or floating. The surface shall be cleared of all stones, stumps or other objects larger than 1-1/2 inches in thickness or diameter; roots, wire, grade stakes, and other objects that might hinder future turf maintenance operations.

2. When results are not satisfactory because of drought, excessive moisture or other causes, the Work shall be stopped until such conditions have improved or have been corrected.

3. When possible, operations shall be performed parallel to the contour lines and operations uphill and downhill shall be avoided.

3.2 SEEDING

A. Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. Seed shall be applied with equipment designed to give uniform application. Any method or combination of methods which uniformly distributes the seed directly in contact with the soil, covers the seed, and firms the bed, may be selected.

B. Mulching

1. All seeded areas shall be mulched within 24 hours following seed application. The mulching operation shall be in accordance with the Governing Standard.

3.3 HYDROSEEDING

A. Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. The wood cellulose fiber mulch shall be applied at the minimum rate of 2000 lb/acre in two separate operations. Ten percent of the specified rate of fiber mulch shall be applied with the seed and the remainder applied after seeding.

3.4 SODDING

A. Application of Sod

1. Sod shall be placed within 72 hours after preparation of the sod bed. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. When the soil is too dry, the sod shall be cut only after Contractor has watered the sod sufficiently to moisten the soil to the depth at which the sod is to be cut.

2. Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of stripping, transporting, and planting. Dumping from vehicles will not be permitted.

3. The sod shall be transplanted within 24 hours from the time of stripping, unless stored in a satisfactory manner. During delivery and while in stacks, the sod shall be kept moist and shall be protected from exposure to the air and sun.

4. Sod shall be laid smoothly, edge-to-edge, and with staggered joints. The sod shall be immediately pressed firmly into contact with the sod bed by tamping or rolling with

acceptable equipment so as to eliminate all air pockets, provide a true and even surface, and assure knitting.

5. Staking is not required, except in ditch flow lines; however, Contractor will be responsible for replacing all sod that is displaced by erosion during the maintenance period. Only wooden (lath) stakes shall be used.

3.5 WATERING

A. Seeded Areas

1. Watering for seeded areas will not be required.

B. Sodded Areas

1. Contractor shall provide all water, labor, and equipment for watering sodded areas. Sodded areas representing one day's planting shall be watered sufficiently to wet the sod pads and at least 2 inches of the sod bed. Thereafter, in the absence of adequate rainfall, watering shall be performed daily and as often as necessary to keep the sod pads moist at all times. Watering of sod shall continue as needed until final acceptance.

3.6 REPLANTING

A. Seeded Areas

1. Unacceptably seeded areas shall be overseeded or completely reseeded as instructed by Engineer. Unless otherwise permitted by Engineer, reseeding shall be performed during the next planting season.

B. Sodded Areas

1. Prior to acceptance, sodded areas that show signs of substantial desiccation as evident by a loss of color and a distinct yellowing shall be resodded and shall continue to be resodded until an acceptable sod cover is obtained. Replanting operations shall be as specified except that fertilizer and lime shall be deleted from the operation.

3.7 MAINTENANCE

A. All areas shall be maintained until final acceptance of the project.

B. Seeded Areas

1. Maintenance shall include any necessary reseeding, repair of erosion damage, and replacement of displaced mulch until covered with seedlings. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired.

C. Sodded Areas

1. Original grades of the sodded areas shall be maintained after commencement of planting operations and until acceptance. Any damage to the finished surface shall be repaired. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired. Ruts, ridges, tracks, and other surface irregularities shall be corrected and areas resodded.

2. During the maintenance period prior to acceptance, all sodded areas shall be mowed to height of 3 inches as soon as, and each time that, the grass reaches an average height of 5 inches . Clippings shall be collected and removed from the Site.

End of Section

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SECTION 33 05 07.23

TRENCHLESS UTILITY

CROSSING

PART 1 – GENERAL

1-1. SCOPE. This specification section contains guidelines and requirements for installation of the 24-inch diameter outfall sewer within a minimum diameter casing pipe shown on the Drawings, using one of the following methods.

1-1.01. Pipe jacking casing pipe using auger boring method of excavation.

1-1.02. Pipe jacking of casing pipe using a shield with excavation by hand or mechanized equipment.

1-3. GENERAL. Any modifications, damages or detrimental consequences to existing structures, facilities or utilities as result of the Contractor's work shall be repaired and restored to its original condition at no additional cost to the Owner.

1-4. DEFINITIONS.

1-4.01. Annular Grouting. Filling annular space between carrier pipe and primary tunnel liner, casing, or ground, by pumping.

1-4.02. Auger Boring. A trenchless method of construction consisting of a horizontal jacking platform within a jacking pit. The pipe is jacked by manual control along the alignment with simultaneous excavation of the soil accomplished by rotating augers in the leading edge of the casing pipe. The spoil is transported to the jacking pit by helical wound auger flights rotatingin the pipe.

1-4.03. Carrier Pipe. As it relates to this work, a pipe for water conveyance.

1-4.04. Casing Pipe. A direct-jacked steel pipe which provides initial ground support for the bore. A casing pipe is not a carrier pipe.

1-4.05. Carrier Pipe Spacers/Insulators. Fabricated item for placing carrier pipe inside casing pipe.

1-4.06. End Seal. Material placed at the interface between the shaft and tunnel to prevent inflows of ground, groundwater, slurry, and/or lubricants into the shaft during tunneling.

1-4.07. Jacking Frame. A structural component, fitted with hydraulic cylinders, which is used to push the cutterhead and casing pipe string into the ground. The jacking frame serves to distribute the thrust load to the casing string and the reaction load to the shaft wall or thrust block.

1-4.08. Shield. Fabricated ground support, circular in section, providing 360 degree protection to workers inside the shield. The shield will have a cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered to install carrier pipe with pipe jacking (single pass).

1-4.09. Thrust Block. An engineered structure designed by Contractor and located between the jacking frame and the launch shaft wall intended to spread the jacking force developed by the hydraulic cylinders over a larger surface area.

1-4.10. Zone of Influence. Area located above the excavation that may be subject to deformation associated with the trenchless operations.

1-4.11. Critical Structure. Any building, structure, roadway, bridge, pier, utility or similar construction partially or entirely located within a zone of influence.

1-5. QUALIFICATIONS.

1-5.01. General. The Contractor trenchless Subcontractor shall demonstrate successful completion of at least five (5) previous projects within the past five (5) years trenchless methods with casing pipe at least 36-inch diameter or larger and 200 feet or greater in length using the methods described in this specification. Qualifications of the Contractor or Subcontractor shall be submitted to the Engineer for review.

1-5.02. Trenchless Foreman. The foreman shall be a trenchless specialist who shall remain on the Site during the duration of the trenchless operation. The foreman and trenchless operator shall have experience on at least five projects using the specified trenchless method in similar soil conditions to the Site subsurface conditions.

1-6. SUBMITTALS. The following shall be submitted to the Engineer in accordance with the Submittals Procedures specification section, prior to commencement of work:

1-6.01. Detailed Work Plan. A detailed work plan shall be submitted. Information shall include, but not be limited to, the following:

a. Trenchless experience of the of Contractor or Subcontractor.

b. Experience of foreman and trenchless operator.

c. Details of the proposed method of construction, sequence of operations, number and size of construction crew(s), hours to be worked and other pertinent information relating to these items.

d. Material and equipment list including detailed information of type, manufacture, and specifications of equipment.

e. If a shield that is separate from mechanized excavation equipment or for use with hand excavation is used, submit arrangement drawings, design criteria, dimensional data and

method of excavation and operation of shield, including acceptable method for supporting, controlling, and closing face of heading.

f. Description of ventilation system, lighting system, and electrical system, if tunneling is performed using a shield.

g. Capacity, number, and arrangement, of main jacks, thrust block and jacking frame details. Provide details of thrust ring, jacking controls, and pressure gages.

h. Details of pipe lubrication and pipe lubricants used during installation, including manufacturer's literature.

i. Spoil handling, transport, and disposal procedures.

j. A plan for monitoring surface settlement including as a minimum: description of monitoring procedures, frequency of measurement and method of measurement. Monitoring plan shall be in accordance with Section 31 09 13 – Geotechnical Instrumentation and Monitoring.

k. Theoretical volume calculation. Contractor shall submit a calculation indicating the theoretical volume necessary to perform the trenchless excavation; a reasonable bulking factor shall be used in this calculation.

l. A list of welding procedures and certifications of all welders to be used on the project. All welding procedures associated with the steel casing pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or special welds for pipe cylinders, casing joint welds, and reinforcing plates. All welding shall be performed by certified welders, welding operators, and tackers who have adequate experience in the type of materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent, local, approved testing agency no more than six (6) months prior to commencing work on this project. Welding machines and electrodes like those proposed for this project shall be used in qualification tests. The Contractor shall bear the expense for welder qualifications.

m. Details of the steel casing pipe to be installed indicating pipe diameter, wall thickness, method of fabrication, material properties, material strength, reinforcement details, grout and lubrication ports and fittings, joint details, and jacking station details, miscellaneous items to be furnished and/or fabricated for the pipe, and other pertinent information as applicable. Indicate the required fabrication tolerances to prevent damage to the pipe during installation and provide a certification from the pipe manufacturer indicating that the steel casing pipe is adequately designed for the project requirements. Provide details to distribute jacking forces at the ends of the pipe joints.

n. Design calculations showing that the proposed steel casing pipe can support the maximum stresses to be imposed on the pipe during jacking. The calculations shall consider maximum ground and hydrostatic loads, jacking forces, contact grouting pressures, external loads such as live loads due to vehicle traffic, construction equipment, stored materials, and any other loads which may be reasonably

anticipated. All loads shall be shown and described. Include the assumed maximum drive length. Maximum compressive bearing stresses shall not exceed specified limits. Contractor shall increase the strength of the pipe and/or pipe joints from as required herein to withstand the stresses imposed by the pipe jacking operations and such increases shall be at no additional cost to the Owner. Calculations shall confirm the steel casing pipe capacity is adequate to resist anticipated jacking loads and all other associated design loads with a minimum factor of safety of 2.5. All calculations shall be prepared, signed, and sealed by a professional engineer licensed in Alabama.

o. The Contractor shall provide an As-Built Report within fourteen (14) days of completion of steel casing pipe installation and contact grouting, but prior to carrier pipe installation, and shall include the following at a minimum:

    1. A summary of project information, including name of Contractor or Subcontractor, date of installation, and contact information.

    2. As-built record drawings of the installed steel casing pipe. The plan and profile drawings shall include the theoretical alignment, actual alignment, survey benchmarks, and other adjacent structures of features, and any other information deemed necessary by the Engineer.

1-6.02. Materials for Contact and Annular Grout

1. Manufacturer's product data sheets indicating:
    a. Mixing, handling, storage, and waste disposal requirements.
    b. Personal safety equipment and first aid measures.
2. Source of supply for each grout ingredient.
3. For each type and source of material:
    a. Cement: Standard physical and chemical analysis.
    b. Admixtures: Documentation showing that the proposed admixtures have a history of demonstrable satisfactory performance.
4. Calibration procedures for gauges and meters to be used in grouting operations.
5. Mix design data for each mix comprising type and proportions of each ingredient.
6. Grout Batching, Delivery, and Placement:
    a. Grouting patterns and details for sequencing and performing grouting.
    b. Means and methods for disposing of wasted or excess grout.
    c. Layout and description of grouting equipment and facilities.
    d. Means and methods for proportioning and mixing grout, measuring grout pressure and injection rates, maintaining grout pressure below specified limits, sequencing grouting.

1-6.03. Construction Schedule. A detailed construction schedule including, but not limited to the following, shall be provided:

a. Preliminary progress schedule, before construction commences.

b. Bi-weekly progress schedule updates

1-6.04. Daily Report. Contractor shall provide a written daily report to Engineer detailing at a minimum the following:

a. Foreman name, hours worked, quantity of crew members, quantity of materials used, and summary of daily activities.

b. A detailed log recording at a minimum: foreman name, trenchless operator name, date, daily progress, jacking pressures, spoil volume and other information deemed necessary by Engineer.

c. Instrumentation data shall be submitted to the Engineer within 24 hours of instrument readings. Data from any monitoring point exceeding the allowable settlement or heave values shall be reported to the Engineer immediately. If any monitoring point indicates settlement or heave beyond the allowable value, the Contractor shall implement the submitted contingency plan.

d. Quantity of muck removed. Contractor shall provide an assessment of the actual spoil volume removed during excavation and the theoretical volume required for the excavation.

1-6.05. As-Built Report. Contractor shall submit an as-built report to the Engineer within fourteen (14) days upon completion of trenchless operations. At a minimum, the report shall include the following:

a. A summary of project information.

b. Name of Contractor, date of installation, and contact information.

c. As-built record drawings of the installed casing and carrier pipes. The plan and profile drawing shall include the theoretical alignment, actual alignment, survey benchmark (northing, easting, and elevation), and other adjacent structures or features.

1-6.06. Excavated Material Disposal.

a. Permits for any proposed off-site disposal sites if required by local, state, or federal ordinance.

b. Written permission from the property owner of proposed off-site disposal site(s) along with a description of the property including its current and future land use/zoning designation.

c. Written and signed release from property owner of off-site disposal site upon completion of disposal work.

1-6.07. Installation of Carrier Pipe.

a. Pipe Design and Installation Method: A brief description of the method of transporting pipe into the casing; method of hoisting and positioning pipe; method of jointing and aligning pipe; and blocking plan. The planned method shall be in accordance with the pipe manufacturer recommendations.

b. Joint Testing: Joint testing procedure and equipment to be used shall be submitted two weeks prior to testing.

1 c. Low density cellular grout mix design used to fill annular space between carrier pipe and the tunnel ~~Annular space between tunnel or bore hole and the carrier pipe shall be backfilled in accordance with Section 31 73 00.01 – Annular Backfill~~.

d. Description of mixing equipment, pumps, and methods and procedures used for placement of the low density cellular grout.

No payment will be made for work until the as-built record drawings have been delivered and accepted by the Engineer.

PART 2 – PRODUCTS

2-1. MATERIALS.

2-1.01. Steel Casing Pipe.

Steel casing pipe shall be a direct-jacked pipe, specifically designed for installation by trenchless methods and shall conform to the requirements herein. Casing pipes shall be of the diameter necessary to subsequently install carrier pipe to the specified line and grade within tolerances and clearances as described by the Contract Documents. Contractor shall be fully responsible for the sufficiency of the casing pipe provided and may select a larger diameter casing or wall thickness for their means and methods, loading characteristics, site conditions, or possible interferences at no additional cost to the Owner.

Casing pipes shall be round, have smooth, even outer surfaces, and have joints that allow for easy connections between pipes. Casing pipe ends shall be square and smooth so that jacking loads are evenly distributed around the entire pipe joint. Casing pipes shall withstand the jacking forces imposed during installation and the final in-place loading conditions. The ends of the pipe shall be protected against damage during installation. Additionally:

a. Pipe lengths shall not be more than twenty (20) feet long.

b. Casing Pipe: Welded steel pipe shall be new, smooth wall, straight seam, conforming to ASTM A139, Grade C or proprietary non-welded steel pipe (Permalok Steel Casing Pipe or equal) shall be new and conforming to ASTM A36/A36M and ASTM A572/A572M, Grade 42. Minimum wall thickness shall be as shown on the Drawings. Minimum yield strength shall be 42,000 psi.

1. Welded steel casing pipe shall be butt welded.

2. Non-welded steel casing pipe shall be manufactured by the rolled and welded cylinder method using the DSAW process in sections not less than eight (8) feet. Non-welded steel pipe connectors shall be full penetration butt welded square to the ends of the pipe sections or profiled directly on the finished section, at the manufacturer's option.

c. Use of other casing pipe types will require prior approval of the Engineer.
d. Casing pipes shall also meet the requirements of the roadway authority having jurisdiction, as applicable.
e. End Closure: As shown on the Drawings.

1 2-1.02. Low Density Cellular Grout. Except as modified in this specification, the Contractor shall conform to the requirements of Section 03 30 00 – Cast-in-Place Concrete. The low density cellular grout shall consist of a mixture of preformed foam, cement, admixtures, and water. The grout shall have a minimum 7-day and 28-day compressive strength of 300 psi and 500 psi, respectively.

PART 3 – EXECUTION

3-1. GENERAL. The Engineer shall be notified at least ten (10) days prior to start of trenchless installation. No operations shall begin until Engineer is present at the Site.

It shall be the Contractor's responsibility obtain permits from all applicable agencies.

Contractor is required to notify Georgia 811 at least three (3) days prior to beginning any excavation. Contractor shall perform all responsibilities outlined in accordance with Georgia 811 guidelines, including white-lining the proposed dig area and potholing all utilities to verify their location.

Perform work in a manner that minimizes ground loss and surface settlement. Furnish equipment, power, water, and utilities for trenchless installation, pipe lubricant mixing, removal and disposal of spoil, and other work required fortrenchless installation.

3-2. EQUIPMENT REQUIREMENTS. Trenchless equipment shall be manufactured by a company that specializes in design and fabrication of this type of equipment and has at least five (5) years of experience. The equipment shall be:

a. Capable of installing steel casing pipe the length of the crossing as shown on the Drawings.

b. Provide a means for controlling line and grade in accordance with specified criteria, centering cutting head inside borehole, and preventing excessive settlement, heave or voids.

c. Equipment shall be hydraulically operated and capable of pushing the pipe in a controlled manner and compatible with the anticipated jacking loads and pipe capacity. Contractor shall monitor the jacking force applied to the pipe and ensure the jacking force does not exceed pipe manufacturer's recommendations.

d. A shield, if used, shall be capable of handling various anticipated ground conditions. In addition, the shield shall:
   i. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. Appropriately sized overcutting bead or taper along length of shield may be provided to facilitate steering. Shield shall be continuous around its full perimeter; open bottom shield is not acceptable. Although it is recognized that capability to over excavate beyond perimeter of shield may be necessary under certain conditions, make provisions to prevent accidental over-excavation.
   ii. Have hood, poling or breasting plates, shelves and breast jacks, breast tables, and combinations of these and other bracing as necessary to fully support face of tunnel excavation without loss of ground.
   iii. Have propulsion system for moving shield in forward direction, while maintaining construction tolerances with respect to line and grade, without damage to carrier pipe. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing of carrier/jacking pipe.
   iv. Have motors and operating controls protected against water inflow.

3-3. SITE CONDITIONS. Conduct operations such that trucks and other construction vehicles do not create a dust nuisance in roadways and adjacent properties. Promptly clean up, remove, and dispose of any nuisance spoil or slurry spillage.

The Contractor shall continuously keep the launch pit free from ground and surface water during operation to the extent practical and shall be prepared to implement groundwater control on short notice, even if observed water levels prior to construction are below the invert of the casing pipe.

Excavation for launch pit, receiving pit, and spoil shall be contained onsite or hauled to an offsite dump site.

Upon completion of work, Contractor shall ensure the work site is restored to pre- construction conditions or as directed by the Engineer.

3-3. LAUNCH AND RECEIVING PITS. All launch and receiving pits shall be protected with suitable fencing or barricades to prohibit unauthorized access. Jacking and receiving pits excavation support shall be in accordance with Section 31 75 00 – Shaft Excavation and Protection.

The jacking and receiving pits shall be backfilled and compacted in accordance with specification Section 31 23 33 – Trenching and Backfilling.

3-4. INSTALLATION.

3-4.01. Tunnel Excavation.

a. Mechanically bore through soil by a continuous auger mounted inside the pipe. The trenchless operations shall be performed simultaneously, with continuous installation of casing pipe. Auger shall not be greater than the outside diameter of the casing pipe.
b. Monitor volume of material excavated and adjust auger rate to avoid loss of ground, over-excavation, settlement and surface heave.

3-4.02. CASING PIPE INSTALLATION.

A. Jacking casing pipe shall be completed in accordance with the shop drawings, and within specified tolerances.

1 B. Prior to starting ~~microtunneling~~ auger boring or shield tunneling operations, CONTRACTOR shall survey the location and orientation of pipe guide rails to ensure proper line and grade and verify proper support. Pipe guide rails shall be carefully set in the jacking pit to ensure correctness of alignment, grade, and stability.

C. Installation Procedures.

1. CONTRACTOR shall follow procedures for casing pipe installation as stipulated below:

a. Set the pipe to be jacked on a properly braced and supported pipe guide.
b. Do not exceed 90 percent of the jacking force recommended by the pipe manufacturer for jointing or pushing pipe.
c. Do not exceed 90 percent of the maximum jacking capacity of the hydraulic jacks.
d. Jack casing~~t~~ into position following the design line and grade without damaging pipe. Provide thrust blocks to transfer the jacking load without causing deformation of the soil or misalignment of jacking frame. Thrust blocks shall withstand the maximum anticipated jacking pressure, with a minimum factor of safety of 2.5, without excessive deflection or displacement.
e. In the event a section of casing pipe is damaged during the jacking operation, jack through to the receiving shaft and remove. Other methods of repairing damaged pipe may be used, subject to the approval of Engineer.
f. Inject pipe lubricants continuously as pipe is advanced. Injection volume shall be not less than the volume of annular void space around the pipe.
g. Control the excavation quantity to only the materials physically displaced by the auger, and pipe string.
h. When tunneling with a shield, control the excavation as follows:
1) Trim excavation in manner so that at least one third of circumference of excavation conforms to contour and grade of casing pipe. Provide clearance of not more than two (2) inches for upper half of ~~carrier or~~ casing pipe with clearance tapering off to zero at point where excavation conforms to contour of ~~carier or~~ casing pipe. Cutting edge of steel plate installed around head end of casing pipe extending short distance beyond end of casing pipe with inside angles or lugs to keep cutting edge from slipping back onto casing pipe may be used.

1

2) Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.
3) At all times maintain standby face supports to allow for immediate use.
4) At end of each shift and whenever excavation is suspended or shut down, install breast boards, or other approved methods, across full face of heading

i. Monitor the volume of material excavated and adjust the advance rate to prevent loss of ground, settlement, voids, cracking, or over-excavation, and surface heave.
j. Monitor and record thrust force for each carrier pipe or casing pipe section, and all pertinent construction records as listed in subparagraph 1.05F of this section.
k. Disconnect lubrication lines and replace plugs in lubrication ports.

3-4.03. Carrier Pipe Installation. Follow the procedures for pipe installation set forth herein.

a. Once the casing pipe is in place, the carrier pipe shall be installed inside the casing. The carrier pipe shall be installed with restrained joints. The carrier pipe shall be centered within the casing using stainless steel spacers. The spacers shall be equally spaced along the length of the pipe. All carrier pipe joints in the casing shall be restrained including the first joints outside the casing pipe.

1 3-5. SPOIL TRANSPORT AND DISPOSAL. Spoil from trenchless operations shall be ~~removed by the helical wound flights to the jacking pit and stored onsite or~~ disposed of ~~properly at an~~ offsite in accordance with specification Section 31 23 11 – Excavation and Fill for Structures~~facility~~.

3-6. CONTROL OF LINE AND GRADE. Benchmarks and other survey control shall be established by the Contractor. Accuracy of the benchmarks shall be verified at the beginning of construction by the Surveyor.

If the pipe installation exceeds specified tolerances, perform corrective work as approved by the Engineer and at no additional cost to the Owner.

3-6.01. Tolerances. Install casing pipe to meet the following tolerances along the alignment:
Horizontal Tolerance: Plus or minus 0.5 inches from horizontal (line) alignment as shown on the Drawings from any point between the shafts.

Grade Tolerance: Plus or minus one 0.25 inches from vertical (grade) alignment as shown on the Drawings from any point between the shafts

3-7. GROUNDWATER CONTROL. Control of groundwater shall be in accordance with the requirements in Section 31 23 19 – Dewatering.

3-8. VENTILATION. Contractor shall provide adequate ventilation complying with all relevant OSHA regulations and shall design the ventilating system to include such factors as the volume required to furnish fresh air and the volume to remove dust and vapor that may impact the laser guidance system. The ventilation system shall be designed considering all internal combustion equipment that may be

used in and near the shaft. When personnel entry is required, gas testing shall be carried out in accordance with OSHA requirements.

All work areas, including shaft access, ladders, and trenchless operation activities (above and below the surface), shall be lighted to ensure proper workspace safety and visibility complying with all relevant OSHA regulations. The lights shall be on a separate circuit from other equipment.

Underground spaces, whether completed or under construction, shall be kept clear of water, slurry, lubricant, hydraulic oil, and excavated material, to the extent practical.

3-9. INSTALLATION OF CARRIER PIPE

A. Immediately prior to moving a pipe section into the tunnel:

1. Remove foreign matter and contaminants from the pipe surfaces.

B. Transport pipe in tunnel for final placement so that no damage occurs to pipe ends or pipe barrel and interior lining or exterior coating.

C. Install required supports and devices for aligning and positioning each pipe section to the required line and grade.

D. Place low density cellular backfill using methods as required to avoid pipe flotation and damage to the pipe. Inject grout on either side of the pipe simultaneously. Complete each lift for a particular section of tunnel being backfilled before starting the next lift in that length of tunnel being backfilled and before starting the first lift of a succeeding length of tunnel being backfilled.

The carrier pipe shall be installed within the casing pipe by Contractor in the presence of Engineer. Installation shall be in accordance with Section 40 05 31.16– Polyvinyl Chloride (PVC) Sewer Pipe and in accordance with the recommendations of the pipe manufacturer.

End of Section

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SECTION 33 05 14 - MANHOLE AND VAULT COVERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the fabrication and erection of iron manhole and vault covers and accessories suitable for installation in manholes, vaults, slabs, electrical handholes, and other applications where a floor access hatch is not required. Manhole steps (suitable for both cast-in-place and epoxy grouted installations) are also included. For floor access hatches and doors see the specification section of the same name.

B. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete data, detailed drawings, and setting or erection drawings covering all materials shall be submitted in accordance with the Submittals Procedures section. Each separate piece shall be marked.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Materials shall be stored on blocking and protected from the weather so that no metal touches the ground and water cannot collect thereon.

PART 2 - PRODUCTS

2.1 GENERAL

A. Materials work shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses as specified or as indicated on the Drawings.

B. All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.

C. The following Owner lettering shall be cast into the covers: SEWER

2.2 DESIGN REQUIREMENTS

A. Manhole and electrical vault covers and frames shall be cast iron assemblies specifically intended as covers. Manufacturer, product number, and type shall be as specified.

B. All covers and frames shall be capable of carrying an AASHTO HS-20 street loading unless specifically indicated as light duty. An equivalent heavy duty cover and frame may be substituted for the indicated light duty cover and frame.

2.3 MATERIALS

A. Materials, appurtenances, and finishes used in the manufacturer of manhole and electrical handhole covers and frames shall be as indicated. Unless otherwise required, materials, appurtenances, and finishes shall be the manufacturer's standard for the type of each cover indicated.

Circular Covers and Frames

Light Duty	Cast iron; Clay & Bailey "2020," Neenah "R-1737," or equal.
Heavy Duty (Subject to Vehicular Traffic)	Cast iron; Clay & Bailey "2008BV," Neenah "R-1736," or equal.

Rectangular Covers and Frames

Light Duty	
Square	Cast iron; Neenah "R-6660," or equal.
Rectangular	Cast iron; Neenah "R-6661," or equal.
Heavy Duty (Subject to Vehicular Traffic)	
Square	Cast iron; Neenah "R-6662," or equal.
Rectangular	Cast iron; Neenah "R-6663," or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prior to installation all loose rust shall be removed from castings and one coat of coal tar epoxy shall be applied to surfaces embedded in concrete. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer.

B. After erection covers and frames shall be cleaned. Product finishes damaged during erection, shall be repaired as recommended by the manufacturer.

End of Section

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SECTION 33 05 16.16 - PRECAST CONCRETE VAULTS AND CHAMBERS DRY-UTILITY APPLICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes the material, testing, and manufacturing requirements of Precast Concrete Utility Structures

1. Electrical manholes, vaults, splice boxes, and handholes.
2. Telecommunications manholes, vaults and handholes
3. Fiber Optic manholes, vaults and handholes
4. Natural Gas manholes, vaults and handholes
5. Chemical feed pull boxes, injection vaults, and enclosures

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

B. ACI International (ACI):

1. ACI 318/318R Building Code Requirements for Structural Concrete and Commentary

C. ASTM International (ASTM):

1. ASTM C 891 Standard Practice for Installation of Underground Precast Concrete Utility Structures
2. ASTM C 857 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. ASTM C 858 Specifications for Underground Precast Concrete Utility Structures.
4. ASTM A 36 Standard Specification for Carbon Structural Steel
5. ASTM A 48 / A48M-03 Standard Specification for Gray Iron Castings

6. ASTM C 1802 Standard Specification for Design, Testing, Manufacture, Selection, and Installation of Fabricated Metal Access Hatches for Utility, Water and Wastewater Structures.

7. ASTM A 536-84 Standard Specification for Ductile Iron Castings

8. ASTM A 82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement

9. ASTM A 185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

10. ASTM A 496 Standard Specification for Deformed for Concrete Reinforcement

11. ASTM A 615/A 615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

12. ASTM A 706/A 706M Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

13. ASTM C 33 Standard Specification for Concrete Aggregates

14. ASTM C 150 Standard Specification for Portland Cement

15. ASTM C 618 Standard Specification for Fly Ash

D. National Precast Concrete Association (NCPA):

1. NPCA Quality Control Manual (2010) Quality Control Manual for Precast Concrete Plants

E. Precast/Prestressed Concrete Institute (PCI):

1. Manual for Quality Control for Plants and Production of Structural Precast Concrete Products (MNL-116)

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s technical data for specified products.

1. Include standard sections and details, dimensions, and profiles.

2. Include openings, cover options, accessories, and design load criteria.

B. Shop Drawings:

Show fabrication details for each precast concrete unit. Include specific structural designs for project-specific units, including units with openings and penetrations.

1. Provide Reinforcing Drawings, Layout Drawings and Shop Drawings.

2. Detail lifting and handling inserts.

3. Include insert requirements, knockout and opening size and location.

4. Indicate location and number or identifier of each precast concrete unit.

C. Delegated-Design Submittal: For precast concrete units, signed and sealed by the qualified professional engineer(s) responsible for their preparation, registered in the state of the project.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Manufacturer.

B. Manufacturer's Quality Control Procedures: Upon request, submit quality control procedures established by the precast manufacturer in accordance with the NPCA Quality Control Manual for Precast Concrete Plants.

C. Material Certificates: Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data.

1. Cementitious Materials: Portland cement, blended cement, pozzolans.

2. Admixtures and curing compound proposed for use on this project

3. Reinforcing materials.

4. Aggregates

D. Upon request the precast concrete manufacturer shall submit plant quality-control reports for the time period when the project specific components were manufactured.

1.5 CLOSEOUT SUBMITTALS

A. Warranty: Signed copy of manufacturer's warranty.

B. Batch Testing: Upon request the precast concrete producer shall submit test reports showing that the mix has been successfully tested to produce concrete with the properties specified.

1. Compressive Strength: ASTM C31 & C39

2. Slump: ASTM C143 or ASTM C1611

3. Air Content: ASTM C173

4. Unit Weight: ASTM C138

5. Temperature: ASTM C1064

C. Plant Quality Assurance and Quality Control Reports

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Precast concrete manufacturer listed in this section or manufacturer approved by Engineer prior to bid in accordance with project bidding requirements, with minimum 5 years experience in manufacture of comparable work to that specified, that assumes responsibility for design and engineering of precast concrete components, including preparation of shop drawings and engineering analysis.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and transport precast concrete units in a position consistent with shape and design to avoid stresses resulting in cracking or damage. All Utility Structure material shall be stored on level ground with proper dunnage supporting each section as indicated by manufacturer.

B. Lift and support precast concrete units at designated points shown on Shop Drawings or Lifting and Handling Insert Details.

1.8 WARRANTY

a. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of precast concrete structures that fail in materials or workmanship within specified warranty period.
b. Warranty Period for Precast Concrete Utility Structures: One year from date of delivery.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Precast concrete Utility Structure manufactured and furnished by American Concrete Products or approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design precast concrete Utility Structure, including engineering analysis by a qualified professional engineer, using specified performance requirements and design criteria.

B. Structural Performance: Design precast concrete Utility Structure to withstand design loads indicated within project conditions.

2.3 PRECAST CONCRETE UTILITY STRUCTURE

A. General:

1. Size and Depth of Bury: As indicated per plans.

2. Basis of Design: The precast concrete structure shall conform to the design requirements of ASTM C857, AASHTO Standard Specifications and ACI 318. In addition, the precast concrete structure shall be designed to resist the pavement, soil weight and at-rest lateral earth pressure, H20 Loading and hydrostatic uplift and lateral forces, including seismic loading per the geotechnical report without leaking or becoming buoyant with a ground water elevation as indicated in the geotechnical report.

3. The precast concrete structure manufacturer shall design the foundation to resist all applicable loads. Contractor shall construct the foundation as required by the manufacturer.

4. Concrete cover requirement shall be a minimum 2” for both interior and exterior surfaces.

5. Pulling Irons: Locate irons directly above or below the projected center of the terminator array or thin-wall knock out, or as indicated in the Contract Drawings. Pulling irons shall have a clear projection into the structure in accordance with the drawings and be designed to withstand a minimum lifting capacity of 7,500 lbs.

6. Utility Termination: Provide thin wall knock-out or terminator arrays for utility termination points. Terminators or knock-out windows can be rectangular or circular consisting of cast-in plastic terminators that can be cut-out in the field to pull cable or install piping. For gas or alternative piping termination points, manufacture circular block outs accommodating pipe type, size and outside diameter of casting and sleeve equipment to be installed in the field, per the Contract Drawings. If required, mechanical thrust blocks shall be cast on wet-utility termination walls.

7. Sump: Sump shall be recessed into floor at low point of vault and shall between 8” to 12” of width, or as required in Contract Drawings.

8. Cable Racking & Equipment Mounting Accessories: Cables shall be supported on walls by cable racks and arms that are sufficient to accommodate power distribution, telecommunications, gas utility pipelines or valves, and fiber optic cables. Mechanical restraints, pipe supports, thrust blocks, and other gas utility pipe mounting equipment shall be designed in accordance with the specifying agency or utility’s Standard Specifications and Details. Cable racks and hooks shall be installed in accordance with the drawings. Methods of cable racks shall be as follows:

9. Provide concrete “spot insert” at each anchor bolt location, cast flush in structure wall.

10. Provide anchors that shall secure equipment mount stanchion to the Utility Structure walls. Cable Racking Stanchions and Arms shall be galvanized steel or non-metallic, with zinc-plated or stainless-steel washers, screws, and accessories.

11. Grounding Systems: If required by the Project Engineer, provide grounding system in accordance with NFPA 70.

12. Grounding Connections: Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld.

13. Provide bare grounding conductors, and covers of Utility Structure with a braided, copper ground strap with equivalent ampacity of # 6 AWG.

14. Grounding: Loop a 4/0 AWG tinned grounding electrode conductor around the interior perimeter and between the cable & equipment racks and as indicated on the Contract Drawings. Connect a tinned bonding jumper that is a minimum of #6 AWG from the grounding electrode to all metal in the Utility Structure. Connect a #6 AWG copper wire to the grounding electrode conductor and exothermic weld cable to ground rod.

15. Fabricated access hatches, doors, grates or covers required for equipment or maintenance access into Utility Structure shall be used only when Utility Structure will experience pedestrian loading, or less than a 16,000 lb. low density traffic single wheel-load. Fabricated access covers shall be manufactured using steel, aluminum, or galvanized steel and torsion-assisted assemblies.

16. Design of fabricated steel or aluminum access hatches shall conform to ASTM C-1802, with load levels corresponding to appropriate use designation.

17. Utility Structure Covers, Frames, and Grates: If Utility Structure will be placed in roadway or loading area that will encounter medium-to-high density AASHTO H-20 or HS-20 loading, the access type shall consist of cast iron ring & cover with concrete flat-top slab.

18. All Castings shall be manufactured to conform to ASTM A48 Class 30B or Class 35. Ductile Iron castings shall conform to the requirements of ASTM A 536.

19. Dimensional tolerance shall not exceed +/- 1/16th" per foot, and casting weights shall not exceed +/- 5%.

20. Iron castings shall be free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their strength and value for service intended.

21. Heavy duty, round manhole frames and covers or grates shall be furnished with machine horizontal bearing surfaces. All other types of castings are furnished with a cast bearing surface unless specified otherwise.

2.4 PRECAST CONCRETE MATERIALS AND MIX DESIGN

A. General: Precast concrete according to ACI 318/318R.

B. Reinforcing Materials:

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

3. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

4. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

5. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I or Type III, gray.

2. Blended Cements: ASTM C 595.

3. Supplementary Cementitious Materials:

a. Fly Ash: ASTM C 618, Class C or F or N.

4. Normal-Weight Aggregates: ASTM C 33, with coarse aggregates complying with Class 4S, free from deleterious or reactive substances.

5. Water: ASTM C 1602, free from deleterious material.

6. Air-Entraining Admixture: ASTM C 260.

7. Chemical Admixtures: ASTM C 494/C 494M, water reducing; high-range water reducing; water reducing and accelerating; and water reducing and retarding. Do not use admixtures containing chlorides.

2.5 CONCRETE DESIGN MIXTURES

A. Prepare design mixtures for each type of precast concrete required, by qualified independent laboratory or by manufacturer's qualified personnel at plant serving project.

B. Proportion normal-weight concrete mixes to provide the following properties:

1. Minimum Compressive Strength: 5000 psi at 28 days.

2. Air Content: 5.5 to 7.5 percent for concrete exposed to freezing and thawing.

C. Concrete Mixing: Comply with ASTM C 94.

D. Finishes: Standard for formed surfaces. Trowel unformed surfaces.

E. Replace precast concrete units deficient in strength, manufacturing tolerances, and finishes.

2.6 FABRICATION

A. Fabricate precast concrete units according to NPCA Manual.

B. Reinforcement: Comply with recommendations for placing, and supporting reinforcement.

1. Fabricated cages of reinforcement either by tying bars, wires or welded wire reinforcement into rigid assemblies or by welding, where permissible, in accordance with AWS D1.4.

C. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Upon request, Owner will engage a representative to evaluate precast structural concrete fabricator's quality-control and testing methods.

B. Testing: Test and inspect precast structural concrete according to referenced design standards.

C. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements

PART 3 - EXECUTION

3.1 INSTALLATION OF PRECAST CONCRETE UTILITY STRUCTURES

A. Excavate trench to the minimum width for the specified size and apply proper shoring techniques. Compact sub-grade per the Geotechnical or Soils Report, or a minimum 90-95% or as specified in ASTM D558. Bed compacted soil with a ¾” Crushed Rock, Pea Gravel, or Fractured Stone and ensure bedded material is level and within ¼” of required grade prior to placement of Utility Structure Sections.

B. Install precast concrete Utility Structure to lines and grades indicated. Lift units by suitable lifting devices at points provided. Install units in accordance with manufacturer's recommendations.

C. Keep all joint surfaces and interior of units free of dirt and other foreign material as setting and sealing of units progresses. Leave installation clean at completion of work.

D. Join precast members in such a manner that ends are fully entered and inner surfaces are flush and even. Check joint and gap immediately after laying each unit.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections: Verify unit placement and joints meet requirements of referenced design and quality control standards.

B. Remove and replace components of the precast concrete structures that do not pass tests and inspections and retest as specified above.

C. Repairing Minor Defects:

1. Fine cracks and checks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless they are numerous and extensive. Cracks which extend into the plane of the reinforcing shall be repaired in an approved manner.

2. Small damaged or honeycombed areas, which are purely surface in nature, shall be repaired in an approved manner. Excessive damage, honeycomb, or cracking will be subject to structural review. All repairs shall be made sound, properly finished, and cured according to the pertinent repair procedure. When fine cracks or hair checks on the surface indicate poor curing practices, the production of precast concrete Utility Structure shall be discontinued until corrections are made and proper curing is provided.

END OF SECTION

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SECTION 33 13 13 - CLEANING AND DISINFECTION OF WATER PIPELINES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers cleaning of potable and non-potable water pipelines and disinfection of all potable water pipelines installed under this Contract.

B. Pipeline pressure and leakage testing is covered in the Pipeline Pressure and Leakage section.

1.2 GENERAL

A. Coordination

1. Contractor shall coordinate cleaning and disinfection work with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.

2. Contractor shall provide all necessary piping, piping connections, temporary valves, backflow preventers, flowmeters, sampling taps, pumps, disinfectant, neutralization agents, chlorine residual test apparatus, and all other items of equipment or facilities necessary to complete the cleaning and disinfection work.

3. Water for cleaning and disinfection work will be provided as stipulated in the Temporary Facilities section.

4. In all cases where it is necessary to interrupt service, permission of Owner shall be obtained at least two days before the service will be interrupted. In all cases where it is necessary to interrupt service to water customers, permission of the Owner shall be obtained and each customer affected shall be notified of the proposed service interruption and its possible duration in accordance with the Project Requirements section.

5. Unless otherwise specified, final cleaning and disinfection work shall not be performed until after hydrostatic testing of the pipelines and any resulting repair work completed.

6. Contractor shall notify the Owner and Engineer prior to the work to allow their representatives to be present during cleaning and/or disinfection of the pipelines.

B. Related Work

1. Other sections directly related to work covered in this section are the Pipeline Pressure and Leakage Testing section.

C. Governing Standard

1. All disinfection work shall conform to the requirements of ANSI/AWWA C651, and the requirements of Alabama Department of Environmental Management (ADEM), Jackson County, and the City of Bridgeport, except as modified herein. If any state or local requirements conflict with the provisions of this section, the state and local requirements shall govern.

2. Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of neutralized or diluted chlorinated water from the final flushing of pipelines and to identify acceptable locations for disposal of the flushing water. All requirements and costs associated with notification and obtaining any discharge permits shall be the responsibility of the Contractor.

D. Experience

1. The disinfection work shall be performed by a subcontractor specialized in such work, or with the permission of Engineer, Contractor may provide the necessary equipment and do the work with his own personnel. In either case, all work shall be done under the direct supervision of a competent and experienced specialist in such work.

2. Personnel performing the disinfection shall demonstrate a minimum of 5 years experience in the chlorination and dechlorination of similar pipelines.

1.3 SUBMITTALS

A. Cleaning and Disinfection Plan

1. Unless otherwise specified, Contractor shall submit a detailed cleaning and disinfection plan to Engineer 14 days prior to starting any cleaning and disinfection work. The plan shall cover the method and procedure proposed, necessary coordination, qualification of personnel performing the disinfection work, sequence of operations, the limits of the pipelines to be cleaned and disinfected, the positions of all valves, location of temporary bulkheads, materials and quantities of each to be used, equipment to be used, manner of filling and flushing the pipelines, chlorine injection points, sample points, bacteriological testing location and schedule, potable water source, method of metering the water if required, neutralization and disposal of wasted water, and all other methods and procedures to be followed in performing the cleaning and disinfection work.

B. Testing

1. Bacteriological testing shall be performed by an independent testing laboratory furnished by Contractor. Contractor shall submit the qualifications of the proposed independent testing laboratory for Owner approval prior to performing the specified bacteriological tests. Upon completion of each test, three copies of the test results shall be submitted to Engineer.

2. Contractor shall provide all items of equipment, piping, and other facilities necessary to assist with the collection of the samples as required. Locations for bacteriological

sampling shall be in accordance with the governing standards or as acceptable to the Owner.

3. The chlorine residual tests shall be performed by Contractor. The test logbook shall be made available to Owner or Engineer upon request and shall be submitted to Engineer upon completion of all chlorine residual testing.

1.4 QUALITY ASSURANCE

A. Chlorine Residual Tests

1. Contractor shall provide the necessary apparatus for making the chlorine residual tests by the drop dilution method in Appendix A of ANSI/AWWA C651. Test results shall be recorded in a logbook that includes for each test: the location, date, time, test results, and test kit manufacturer.

B. Bacteriological Tests

1. Sampling and testing of water in the pipelines shall be performed after final flushing in accordance with Section 5 of ANSI/AWWA C651. Two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected and standard heterotrophic plate counts measured for each sample.

C. Redisinfection

1. Should the bacteriological tests indicate the presence of coliform organisms at any sampling point, the pipelines shall be reflushed, resampled and retested in accordance with Section 5 of ANSI/AWWA C651. If check samples show the presence of coliform organisms, then the pipelines shall be rechlorinated until acceptable results are obtained.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials furnished by Contractor shall conform to the requirements of ANSI/AWWA C651 and shall be clean and free of debris which could infer questionable test results.

B. Liquid Chlorine

1. Liquid chlorine shall conform to AWWA B301.

C. Calcium Hypochlorite (Dry)

1. Calcium hypochlorite shall conform to AWWA B300.

D. Sodium Hypochlorite (Solution)

1. Sodium hypochlorite shall conform to AWWA B300.

E. Chlorine Residual Test Kit

1. Chlorine residual concentration shall be measured using an appropriate range, drop count titration kit or an orthotolidine indicator comparator with wide range color discs. The color disc range shall be selected to match chlorine concentration limits. Test kits shall be maintained in good working order and available for immediate test of residuals at point of sampling. Test kits manufactured by Hach Chemical or Orbeco-Hellige are acceptable.

PART 3 - EXECUTION

3.1 APPLICATION

A. Cleaning

1. Pipelines, including all associated valves and fittings, shall be cleaned to the satisfaction of Owner and Engineer.

2. Small pipelines shall be cleaned by flushing with water at the maximum velocity which can be developed, but not less than 3.0 feet per second , unless otherwise permitted by Engineer. Flushing shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

3. Large pipelines may be flushed as specified for small pipelines, cleaned with a hose, or cleaned by other methods acceptable to Engineer. Flushing or other cleaning methods shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

4. Flushing shall be accomplished through the installed valves or fittings, blow-offs or through temporary flushing connections installed for that purpose and in accordance with any details indicated on the Drawings.

5. Booster pumps shall be used if needed to obtain the necessary volume or velocity of water. Pumping equipment installed under this Contract shall not be used for flushing, nor shall the flushing water be passed through them or other installed equipment; temporary bypass piping at each pump or installed equipment shall be provided as needed.

B. Disinfection Procedure

1. The pipelines shall be disinfected by the tablet method, continuous feed method, or slug method. Potable water shall be used in conjunction with the chlorination agent.

2. For the continuous feed or slug method, the chlorination agent shall be injected into the line at the supply end of each new pipeline or valved section thereof.

3. Admission of disinfectant solution into or the flushing thereof through existing piping shall be held to the minimum possible, and then only after adequate measures have been taken to prevent any such solution of chlorinated wastewater from entering branch service connections to water customers or other piping systems.

4. During disinfection, all valves and hydrants shall be operated to ensure that all appurtenances are disinfected. Valves shall be operated such that the chlorine solution in the pipeline being chlorinated will not flow back into the supply line. Check valves shall be used if needed.

5. Existing pipelines which may become contaminated during work requiring connections to the new pipeline, involving either tapping or cutting into operations, shall be flushed and disinfected in accordance with Section 4 of ANSI/AWWA C651.

C. Final Flushing

1. Upon completion of chlorination, but before sampling and bacteriological testing, all heavily chlorinated water shall be removed from the lines by flushing with potable water until the chlorine residual in the lines is not higher than that generally prevailing in the adjacent existing system or as acceptable to the Owner.

D. Disposal of Chlorinated Wastewater

1. All chlorinated wastewater to be discharged shall be neutralized by chemical treatment and disposed in accordance with Section 4 of ANSI/AWWA C651, ANSI/AWWA C655 and the requirements of the governing agency specified herein. Schedule, rates of flow, and locations of discharge of disinfection and flushing water shall be coordinated with Engineer and in accordance with all applicable rules and regulations.

End of Section

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SECTION 33 14 00 - PIPELINE PRESSURE AND LEAKAGE TESTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers field hydrostatic pressure and leakage testing of piping. The term "piping" shall be used in this section to refer to piping systems, pipelines, or sections thereof.

B. Testing of other piping is covered in the Sewer Pipe Installation and Testing section and Miscellaneous Piping and Accessories Installation section. Cleaning and disinfection of piping is covered in the Cleaning and Disinfection of Water Pipelines section.

1.2 GENERAL

A. Contractor shall coordinate pressure and leakage testing with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.

B. Contractor shall provide all necessary piping, piping connections, temporary valves, backflow preventers, and all other items of equipment or facilities necessary to complete the pressure and leakage testing.

C. In all cases where it is necessary to interrupt service, permission of Owner shall be obtained at least two days before the service will be interrupted. In all cases where it is necessary to interrupt service to water customers, permission of the Owner shall be obtained and each customer affected shall be notified of the proposed service interruption and its possible duration in accordance with the Project Requirements section.

D. Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of water used for pressure and leakage testing and to identify acceptable locations for disposal of the water. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of Contractor.

E. Engineer or Engineer's representative shall be present during testing and shall be notified of the time and place of testing at least 3 days prior to commencement of testing. All testing shall be performed to the satisfaction of Engineer, and in accordance with all governing standards and regulations.

F. Testing Schedule and Procedure

1. A testing schedule and procedure shall be submitted to Engineer for review and acceptance not less than 21 days prior to commencement of testing. The schedule and

procedure shall include, but not be limited to the following information for each pipe section to be tested:

a. limits of each pipe test section;
b. proposed time and sequence;
c. physical locations and set positions of all valves;
d. locations of temporary bulkheads, stops, caps, restraints, supports, and other temporary equipment needed;
e. manner of filling and source of water;
f. method and location of metering volumes;
g. method and location of gauging pressures; and
h. method and location of disposal of test water.

G. Special Testing Requirements

1. Unless otherwise acceptable to Engineer, the general sequence of work for each pipeline, or valved or bulkheaded section thereof, shall be as follows:

a. Initial cleaning and flushing of pipeline.
b. Filling pipeline.
c. Hydrostatic pressure and leakage testing.
d. Disinfection.
e. Final flushing and neutralization of heavily chlorinated water.
f. Bacteriological tests.

2. Unless otherwise acceptable, during testing of the pipeline, all valves, except for auxiliary hydrant valve(s), shall be in the open position. All auxiliary hydrant valve(s) shall be closed during pressure testing so that the test pressure is not applied to the hydrant valve(s). The following valves shall be tested to be drip tight at their rated pressure.

3. Unless otherwise acceptable, temporary bulkheads shall be provided during testing so that the test pressure is not applied to existing or new valves and hydrants, or to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

4. Unless otherwise acceptable, a temporary pressure gauge shall be installed at each end of the limits of the pipeline to be tested.

5. Unless otherwise acceptable, tests shall be conducted before connections are made to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

6. Unless otherwise acceptable, upon completion of testing and disinfection, connections made to existing water lines or to any portion of water lines installed under this Contract that have already been put into service, and any other portion of the pipeline not subject to the pressure test, shall be visually inspected for leakage after placing the water line into service and before backfilling the connection.

7. If testing is permitted against a valve, the maximum differential test pressure across the valve seat (gate) in the closed position shall not exceed the drip-tight rated pressure of the valve.

H. Water

1. Water for testing shall be furnished as stipulated in the Temporary Facilities section. As a conservation measure, the water shall be collected for reuse in subsequent testing. Unless otherwise permitted, the water shall be kept out of the remainder of the piping. Following completion of testing, the water shall be disposed of in accordance with the requirements of regulatory agencies and in a manner acceptable to Engineer.

1.3 SUBMITTALS

A. Test Procedures and Plans

1. Test plans and procedures shall be submitted as outlined in the GENERAL section of this specification.

B. Test Results and Reports

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All necessary connections between the piping to be tested and the water source, together with pumping equipment, water meter, pressure gauges, backflow prevention, and all other equipment, materials, and facilities required to perform the specified tests, shall be provided. All required blind flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices shall also be provided. All temporary sectionalizing devices shall be removed upon completion of testing. Vents shall be provided in test bulkheads where necessary to expel air from the piping to be tested.

B. Test pressure shall be applied by means of a force pump sized to produce and maintain the required pressure without interruption during the test.

C. Water meters and pressure gauges shall be accurately calibrated and shall be subject to review and acceptance by Engineer.

D. Permanent or temporary gauge connections shall be installed at each location where test gauges are connected to the piping during the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent gauge connection shall be fitted with an isolation valve and a permanent gauge, and each temporary gauge connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.

E. Permanent or temporary fill and vent connections shall be installed as needed for the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent fill and vent connection shall be fitted with the permanent fill or vent piping, and each temporary fill and vent connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.

PART 3 - EXECUTION

3.1 FILLING AND VENTING

A. Before filling the piping with water, care shall be taken to ensure that all air release valves and other venting devices are properly installed and operating properly. Hand-operated vent valves shall not be closed until an uninterrupted stream of water is flowing from each valve. The rate of filling the piping with water must not exceed the venting capacity of the installed air vent valves and devices.

3.2 BLOCKING AND BACKFILLING

A. Piping shall be adequately blocked, anchored, and supported before the test pressure is applied. Underground piping identified in the Pipeline Test Pressure Schedule shall be tested before the joints are covered. All other piping may be tested after backfilling.

3.3 PRESSURE TESTING

A. After the piping to be tested has been filled with water, the test pressure shall be applied and maintained without interruption within plus or minus 5 psi of test pressure for 2 hours plus any additional time required for Engineer to examine all piping being tested and for Contractor to locate any defective joints and pipe materials. The test pressure shall be in accordance with the requirements specified for pipeline or plant piping.

B. Pipeline Test Pressure

1. Piping shall be subjected to a hydrostatic test pressure as indicated in the Pipeline Test Pressure Schedule.

2. The test pressure, expressed in feet of water, to be applied at any point in the piping shall be equivalent to the arithmetic difference between the specified test pressure plane elevation and the elevation of the horizontal center line of the piping at the selected location. The value obtained shall be multiplied by 0.433 to obtain psi .

C. Plant Piping Test Pressure

1. Piping shall be subjected to the test pressure as indicated in the Plant Piping Test Pressure Schedule.

3.4 PLANT PIPING LEAKAGE TESTING

A. All plant piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.5 PIPELINE LEAKAGE TESTING

A. The pipeline piping shall be subjected to a leakage test. Leakage testing may be conducted concurrently with pressure testing. The duration of the leakage test shall be 2 hours plus the additional time required for Engineer to make an accurate determination of leakage.

B. Leakage Test Pressure

1. The hydrostatic pressure maintained during the leakage test shall be equal to the pressure specified for pressure testing of the piping and shall be maintained within plus or minus 5 psi during the entire time that leakage measurements are being performed.

C. Leakage Measurement

1. Measurement of leakage shall not be attempted until all trapped air has been vented, absorption of water by the pipe wall or lining has stabilized, and a constant test pressure has been established. After the pressure has stabilized, piping leakage shall be measured with a suitable water meter installed in the pressure piping on the discharge side of the force pump.

D. Allowable Leakage

1. The term "leakage", as used herein, refers to the total amount of makeup water which must be added into the piping during the test to maintain the test pressure.

2. No piping will be accepted if and while it exhibits a leakage rate in excess of that determined by the indicated formulas:

$Q = 0.00676\ DLN$ (using inch-pound units)

Where

Q = allowable leakage in gallons per hour

D = nominal diameter of pipe in inches

L = length of section tested in thousand feet

N = square root of weighted average test pressure in pounds per square inch**]**

$Q = 1.26 \times 10^{-6}\ DLN$ (using SI units)

Where

Q = allowable leakage in liters per hour

D = nominal diameter of pipe in millimeters

L = length of section tested in meters

N = square root of weighted average test pressure in kilopascals

3. The weighted average test pressure shall be equivalent to the arithmetic difference between the specified test pressure plane elevation in feet and the average elevation of the pipeline in feet , multiplied by 0.433 to obtain psi . The weighted average elevation of the pipeline shall be calculated by (1) breaking the pipeline into sections at each significant change in slope and multiplying the average elevation of each section by the length of each section, (2) then summing the products, and (3) dividing the sum by the total length of the pipeline.

4. Whenever the piping to be tested contains pipe of different diameters, the allowable leakage shall be calculated separately for each diameter and the corresponding length of piping. The resulting allowable leakage rates shall be added to obtain the total allowable leakage for the entire piping.

5. All joints in piping shall be free from visible leaks during the leakage test. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor regardless of the amount that the total leakage may have been below the specified allowable leakage rate during the leakage test.

6. If the leakage test indicates a higher than allowable leakage rate, Contractor shall locate and repair leaking joints and other defective work and repeat the test the until leakage rate is less than the allowable rate.

End of Section

SECTION 33 31 33 - SEWER PIPE INSTALLATION AND TESTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation and testing of all sewer pipe furnished under the following specification sections:

1. Polyvinyl Chloride (PVC) Sewer Pipe

B. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Pipe, fittings, and appurtenances shall be transported, stored, and handled in a manner which prevents damage. Hooks shall not be permitted to come in contact with joint surfaces. Plastic pipe shall be shaded if necessary to prevent curvature due to thermal expansion. Damaged pipe and fittings shall be removed from the site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sewer pipe materials are specified in the pipe sections.

PART 3 - EXECUTION

3.1 ALIGNMENT

A. Piping shall be laid to the lines and grades indicated on the Drawings. Laser beam equipment or surveying instruments shall be used to maintain alignment and grade. At least one elevation measurement shall be made on each length of pipe.

3.2 LAYING PIPE

A. Pipe shall be protected from lateral displacement by embedment material installed as specified in the Trenching and Backfilling section. Pipe shall not be laid in water or under unsuitable weather or trench conditions.

B. Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

C. Foreign material shall be kept out of the pipe during installation. No debris, tools, clothing, or other foreign objects shall be placed in the pipe.

D. Whenever pipe laying is stopped, the open end of the pipe shall be closed with a tight-fitting end board to keep out soil. The end board shall have perforations to admit water and prevent flotation of the pipe in the event the trench becomes flooded.

E. Core holes and handling holes in concrete pipe shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to Engineer. Plugs shall be provided by the pipe manufacturer and shall be sized and designed to match the pipe supplied.

3.3 JOINTING

A. All joint preparation and jointing procedures shall comply with the instructions and recommendations of the manufacturer.

B. Rubber Gasketed Joints

1. Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be thoroughly cleaned and coated with the lubricant furnished with the pipe. The gasket shall be lubricated and positioned in the spigot groove so that the gasket is distributed uniformly around the pipe circumference. The position of the rubber gasket shall be checked with a feeler gauge after each joint is completed. If the gasket is not in the proper position, the joint shall be pulled apart, the gasket removed and discarded, and the joint re-assembled using a new, properly lubricated gasket.

2. Joint lubricant shall be stored in closed containers and shall be kept clean. When installing pipe in cold weather, the joint surfaces and gaskets shall be kept warm and the joint lubricant shall be protected from freezing.

3. For rubber and steel joints, each exterior joint recess shall be filled with joint grout. A diaper shall be used to prevent foreign material from entering the joint recess before grouting and to serve as a form for the grout. Each diaper shall be of sufficient length to encircle the pipe, leaving enough space between the ends to allow the grout to be poured. Joint grout shall be poured between the diaper and the pipe and shall be allowed to run down to the bottom of the pipe. The grout shall be rodded while being poured, using a

stiff wire curved to the approximate shape of the pipe. Each joint recess shall be completely filled with grout for the full circumference of the pipe.

4. Not less than two lengths of pipe shall be in final position in advance of exterior joint grouting. If placing of pipe embedment is resumed before the grout has attained initial set, care shall be taken to prevent damage to the grout while placing and compacting embedment material.

5. After trench backfilling has been completed, the interior joint recess of pipe with rubber and steel joints shall be filled with mortar following the recommendations of the pipe manufacturer. Joint surfaces shall be damp, but free from standing water, when the mortar is placed. Mortar shall be thoroughly compacted to completely fill the recess and shall be finished smooth. All excess mortar shall be removed from the pipe.

C. Flexible Sealant Joints

1. Joints made with flexible joint sealant shall be coated with adhesive as directed by the sealant manufacturer, and the joint sealant shall be positioned in accordance with the manufacturer's installation instructions. The pipe sections forming the joint shall be pulled together with sufficient force to uniformly fill and seal the annular space in the joint. Joints shall not be made when adverse weather conditions may prevent proper sealing, nor when the temperature of the pipe and sealing materials is too low to achieve proper sealing.

D. Mastic Joints

1. Surfaces of pipe to be joined with mastic joints shall be primed, if recommended by the mastic manufacturer. Immediately before joining the pipes, a uniform layer of mastic shall be applied to the joint surfaces. After the pipes are in final position, the mastic shall completely fill and seal the annular space in the joint. Joints shall not be made when weather conditions may interfere with obtaining a satisfactory seal.

E. Field Cut Joints or Connections Between Dissimilar Pipe Materials

1. Where indicated on the Drawings or required to facilitate installation of field cut joints in PVC or composite sewer pipe, or connections between PVC or composite sewer pipe and pipe of other materials, couplings may be used in accordance with the instructions of the coupling manufacturer and pipe manufacturer.

3.4 TEE BRANCHES – Not Used

3.5 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed where indicated on the Drawings. A pipe joint shall be provided within 12 inches of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section. All pipe which is to be encased

shall be suitably supported and blocked in proper position and shall be anchored against flotation.

3.6 ACCEPTANCE TESTS

A. Each reach of sewer shall meet the requirements of the following acceptance tests. All defects shall be repaired to the satisfaction of Engineer.

B. Low Pressure Air Testing

1. Air testing shall not be used for manholes, or for pipe larger than 24 inch in diameter.

2. Low pressure air testing shall comply with ASTM C828 for PVC, and composite pipe, and shall comply with ASTM C924 for concrete pipe. The schedule of testing shall be submitted to Engineer prior to starting the tests. The time of conducting the tests shall be acceptable to Engineer.

3. The time elapsed for a 1 psi drop in air pressure shall be not less than, nor shall the air loss exceed, the limits set forth in the governing standard.

4. If the length of sewer to be tested is fully or partially submerged in groundwater, the test pressure shall be increased if necessary to overcome the actual static pressure exerted by the groundwater.

5. Leaks shall be located by testing short sections of pipe. Leaks shall be repaired and the reach of sewer retested.

C. Infiltration

1. If, at any time prior to expiration of the correction period stipulated in the General Conditions, infiltration exceeds 100 gallons per inch of nominal diameter per mile [9 L/mm of nominal diameter/km] of sewer per day, Contractor shall locate the leaks and make repairs as necessary to control the infiltration.

D. Deflection

1. Deflection test shall be performed on PVC sewer pipe 15 inch in diameter or larger.

2. After backfilling is completed, and before acceptance of the work, each reach of PVC and composite sewer pipe shall be checked for excessive deflection by pulling a mandrel through the pipe, or by other methods acceptable to Engineer. Pipe with diametrical deflection exceeding 5 percent of the inside diameter shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3.7 CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until the work has been accepted. All joint contact surfaces shall be kept clean until the joint is completed.

End of Section

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SECTION 33 39 13 - SANITARY UTILITY SEWERAGE MANHOLES, FRAMES, AND COVERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of standard and drop sewer manholes. Standard and drop manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details in the figures at the end of this section.

B. Where required, special manholes shall be constructed in accordance with the details indicated on the Drawings.

C. Steps, frames, and covers for structures other than sewer manholes are covered in other sections.

1.2 GENERAL

A. At the option of Contractor, standard and drop manholes may be constructed with cast-in-place concrete bases or precast concrete (developed) bases as indicated on the figures.

B. Only manholes which are required to have inside/outside pipe and fittings for dropping sewage into the lower line will be designated as drop manholes. Inside drop manholes where the incoming line discharges directly into the manhole and which do not require special fittings will be considered standard manholes.

1.3 SUBMITTALS

A. Drawings and Data

1. Drawings and data covering precast concrete sections and castings shall be submitted in accordance with the Submittals Procedures section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

C. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

Precast Concrete Manholes and Reinforcement	ASTM C478, except as modified herein.
Cement	Cement type shall comply with ASTM C150, Type II. Water-cementitious materials ratio shall not exceed 0.40. Alternative materials proposed by Contractor that will provide equivalent corrosion protection and durability may be submitted subject to review and acceptance by Engineer.
Riser and Precast Base	Circular, uniform outside diameter.
Minimum Wall Thickness	1/12 of inside diameter, plus 1 inch .
Cone	Shape shall be concentric or flat as required; wall thickness as specified for riser sections.
Adjusting Rings	Circular, with shear keys.
Cast-in-Place Concrete Bases	Materials, handling, forms, finishing, curing, and other work as specified in the cast-in-place concrete section.
Nonshrinking Grout	L&M "Crystex", BASF Master Builders "Masterflow 713 " or "Set Grout", Sauereisen Cements "Grout No. F-100 Level Fill Grout", , or Five Star Products "Five Star Grout".
Resilient Manhole/Pipe Connectors	A-LOK Premium manhole pipe seal.
Mastic Fill	Butyl rubber compatible with resilient connector material.
Gaskets	
Mastic	ASTM C990; Hamilton-Kent "Kent-Seal No. 2", , or Henry Company "Ram-Nek". Cross-sectional area as recommended by manhole manufacturer.
Rubber	ASTM C361, Section 6.9, except gasket shall be synthetic, with hardness of 40 ± 5 when measured by ASTM D2240, Type A durometer. Natural rubber will not be acceptable.
Rubber Joint Filler	Synthetic.
Hardness	40 ± 5 when measured by ASTM D2240, Type A durometer.

Tensile Strength	1,200 psi minimum.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300M", or Tnemec "46H-413 Hi-Build Tneme-Tar".
Castings	ASTM A48, Class 35B or better.
Manhole Rings and Covers	Clay and Bailey "No. 2032" or Neenah Foundry "R-1769-A".

2.2 MANUFACTURE

A. The first riser sections for use with cast-in-place bases shall be provided with horseshoe-shaped boxouts for connecting piping to be grouted in, or with circular openings with continuous, circular, resilient connectors cast into the riser wall. Boxouts for grouting, if used, shall have surfaces grooved or roughened to improve grout bond.

B. Precast base sections shall be provided with circular openings, with continuous, circular, resilient connectors cast into the wall.

C. Resilient connectors shall be installed in accordance with the manufacturer's recommendations, except that connectors shall be positioned so that sealing or resealing operations may be accomplished from inside the manhole.

D. Precast sections may be provided with lifting notches on the inside faces of walls to facilitate handling. Lifting notches shall be not more than 3 inches deep; holes extending through the wall will not be acceptable.

E. If precast concrete base sections are used, part of the concrete invert fill may be furnished with the precast unit; however, a rough surface shall be provided to improve bond with the final invert fill. At least the top 2 inches of the concrete invert fill shall be installed in the field.

PART 3 - EXECUTION

3.1 INSPECTION

A. Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units shall be rejected.

3.2 CONSTRUCTION

A. Bases

1. If cast-in-place concrete bases are used, concrete shall be placed on undisturbed earth in accordance with applicable requirements of the Concrete section.

2. If precast concrete (developed) bases are used, the subgrade materials shall be excavated to undisturbed earth and to a uniform elevation which will permit at least 4 inches of granular embedment material, as specified in the Excavation and Fill for Structures section, to be installed and compacted. The surface of the granular material shall be carefully graded and the base section accurately set so that connecting pipes will be on proper line and grade. The elevation of the granular material shall be adjusted until proper grade and alignment of the base section has been attained.

3. No wedging or blocking under precast concrete bases will be permitted.

4. When resilient connectors are used with cast-in-place bases, the concrete fill under the connecting pipe outside the manhole shall be deleted and shall be replaced with granular embedment material to undisturbed earth.

5. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with a radius of curve as large as practicable. All inverts shall be troweled to a smooth, clean surface.

B. Riser and Cone Sections and Precast Concrete Adjusting Rings

1. Circular precast sections and rings shall be provided with a rubber or mastic gasket to seal joints between sections and rings. Mastic gaskets shall be used only at temperatures recommended by the manufacturer. Lifting notches in manhole walls shall be filled with nonshrinking grout.

2. Manhole steps are not required.

C. Connecting Piping

1. The space between connecting pipes and the wall of precast sections shall be completely filled with non-shrink grout, except where resilient connectors are provided.

2. When resilient connectors are used, the connecting pipe shall be carefully adjusted to proper line and grade, and the bedding material shall be compacted under the haunches and to the spring line of the pipe for a distance of at least 6 feet from the manhole wall and to at least the minimum trench width. The pipe shall be installed in the resilient connector prior to backfilling outside the manhole and shall be resealed after completion of the manhole and backfill. All visible leakage shall be eliminated.

3. The connecting pipe for installation with resilient connectors shall be plain-end, square cut spigots and shall not protrude more than 1 inch inside the manhole wall. A clear distance of at least 1 inch from the end of each connecting pipe and around the pipe shall be provided when the concrete invert fill is installed. After completion of the manhole, the boxout shall be filled with mastic filler material, completely filling the space beneath

the pipe and extending to at least the spring line. The filler material shall provide a smooth, uniform surface between the inside diameter of the pipe and the manhole invert.

4. At each special manhole, rubber joint filler shall be provided around connecting piping. The filler shall be securely fastened in place with suitable wires or straps.

3.3 CASTING COATING

A. Prior to installation, one coat of coal tar epoxy shall be applied to all castings. Before coating, castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the coating is dry and hard.

End of Section

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SECTION 40 05 05.11 - MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of piping and accessories as indicated on the Drawings for the following piping sections:

1. Miscellaneous Piping and Accessories
2. Miscellaneous Steel Pipe, Tubing, and Accessories
3. Miscellaneous Plastic Pipe, Tubing, and Accessories
4. Cast Iron Soil Pipe and Accessories
5. Copper Tubing and Accessories

B. Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.

C. Pipe supports and anchors shall be furnished by Contractor, and are covered in the Pipe Supports section. Pipe trenching and backfilling are covered in the Trenching and Backfilling section.

1.2 GENERAL

A. Coordination

1. Materials installed under this section shall be installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but not be limited to, the following:

a. Chlorine tank car unloading connection.
b. Cleaning procedure for metal chlorine piping.
c. Watertight/dusttight pipe sleeves.

d. Materials as specified herein.

B. Welder Certification

1. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.

1.4 QUALITY ASSURANCE

A. Welding and Brazing Qualifications

1. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be submitted to the Engineer for review.

B. Tolerances

1. These tolerances apply to in-line items and connections for other lines.

2. The general dimension, such as face-to-face, face or end-to-end, face- or end-to center, and center-to-center shall be 1/8 inch .

3. The inclination of flange face from true in any direction shall not exceed 3/64 inch per foot .

4. Rotation of flange bolt holes shall not exceed 1/16 inch .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F .

C. Coated Pipe

1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic-coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pipe, tubing, and fittings covered herein shall be installed in the services indicated in the various pipe sections.

2.2 MATERIALS.

A. Threaded Fittings

1. Anti-Seize Thread Lubricant: Jet-Lube "Nikal," John Crane "Thread Gard Nickel," Never-Seez "Pure Nickel Special," or Permatex "Nickel Anti-Seize."

2. Teflon Thread Sealer: Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon."

3. Teflon Thread Tape: Hercules “Tape Dope” or John Crane “Thread Tape.”

B. Solvent Welded Fittings

1. Solvent Cement for PVC Systems: ASTM D2564.

2. Solvent Cement for CPVC Systems: ASTM F493.

a. Sodium Hypochlorite, Sodium Hydroxide, and Sodium Bisulfate Service: IPS Corporation “Weld-On 724.”

3. Primer for PVC Systems: ASTM F656.

C. Solder or Brazed Fittings

1. Solder: Solid wire, ASTM B32, ANSI/NSF 61 and ANSI/NSF 600 certified; Alloy Grade Sb5, (95-5).

2. Soldering Flux: Paste type, ASTM B813.

3. Brazing Filler Metal: AWS A5.8, BCuP-5; Engelhard “Silvaloy 15,” Goldsmith “GB-15,” or Handy & Harman “Sil-Fos.”

4. Brazing Flux: Paste type, Fed Spec O-F-499, Type B.

D. Insulating Fittings

1. Threaded: Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene-lined, zinc plated, Perfection Corp. “Clearflow Fittings.”

2. Flanged: Epco “Dielectric Flange Unions” or Central Plastics “Insulating Flange Unions.”

E. Pipe Insulation: See Mechanical Insulation section.

F. Watertight/Dusttight Pipe Sleeves: O-Z Electrical Manufacturing “Thruwall” and “Floor Seals,” or Thunderline “Link Seals,” with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.

1. Pipe Sleeve Sealant: Polysulfide or urethane, as specified in the Caulking section or as indicated in the Drawings.

G. Protective Coatings

1. Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils ; Protecto Wrap “200” or Tapecoat “CT.”

2. Primer: As recommended by the tape manufacturer.

3. Coal Tar Epoxy: High build coal tar epoxy; PPG Amercoat “Amercoat 78HB Coal Tar Epoxy,” Carboline “Bitumastic 300 M,” Tnemec “46H-413 Hi-Build Tneme-Tar,” or Sherwin-Williams “Hi-Mil Sher-Tar Epoxy.”

4. Epoxy for aeration and process air piping: Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300° F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline “Thermaline 450,” PPG Amercoat “Amerlock 400 with Amercoat 880 Additive,” or approved equal.

H. Chlorine Tank Car Unloading Connection: Special flanged hose assembly conforming to materials and details on Drawing No. 135, The Chlorine Institute, Inc.

PART 3 - EXECUTION

3.1 INSPECTION

A. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION

1. Field Measurement

    a. Pipe shall be cut to measurements taken at the site, not from the Drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION

A. General

1. All instruments and specialty items shall be installed according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance.

2. Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.

B. Pipe Sleeves

1. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the Drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch nor more than 2 inches above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the Drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

2. Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.

3. Unless otherwise indicated on the Drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.

C. Pipe Joints

1. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.

2. Threaded

   a. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs. Unless otherwise indicated, threaded joints shall be made up with teflon thread tape, thread sealer, or a suitable joint compound.
   b. Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads. Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.

3. Compression

   a. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

4. Flared

   a. Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as needed to produce leaktight connections.

5. Soldered and Brazed

   a. Where solder fittings are specified for lines smaller than 2 inches , joints may be soldered or brazed at the option of Contractor. Brazing alloy shall contain no tin.
   b. Surfaces to be joined shall be thoroughly cleaned with flint paper and coated with a thin film of flux. At each joint, tubing shall enter to the full depth of the fitting socket.
   c. Care shall be taken to avoid overheating the metal or flux. Each joint shall be uniformly heated to the extent that filler metal will melt on contact. While the joint is still hot, surplus filler metal and flux shall be removed with a rag or brush.

6. Solvent Welded

   a. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed. Solvent welding

shall be performed by bonding operators who have met the requirements of ASME B31.3 and A328.

7. Epoxy and Adhesive Bonded

   a. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.

8. Heat Fusion Bonded

   a. Heat fusion bonded joints shall be used for polyethylene pipe with socket and butt fusion fittings. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.

9. Flanged

   a. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.
   b. Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:
      1) Vertical flange face: Bolt holes to straddle the vertical centerline.
      2) Horizontal flange face: Both holes shall be aligned with connecting pipe.
   c. Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.
   d. Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.
   e. Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.
   f. Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

g. Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.
h. Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.

10. Welded

a. Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1.
b. Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16 inch . Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.
c. Stainless steel welding shall be inert gas tungsten arc (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG). Refer to the stainless steel piping section for additional welding requirements.
d. Carbon steel welding shall be made by the shielded metal arc process.
e. For socket weld joints, fully engage the two pipe ends, then separate them by 1/16 inch prior to welding to all space for shrinkage.

11. Grooved Couplings

a. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.

12. Push-on

a. Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

13. Rubber-Gasketed

a. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps

for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

14. Other Pipe Joints

a. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.

D. Pipe

1. Pipe shall be installed as specified, as indicated on the Drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.

2. Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.

3. Piping shall be supported in conformance with the Pipe Supports section.

4. Piping shall be connected to equipment by flanges or unions as specified in the various piping sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.

5. Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the Drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.

6. A union shall be provided within 2 feet [600 mm] of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the Drawings or the Specifications.

7. All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Process Air	1/2 inch OD
Air signal	1/4 inch OD
Power air	1/2 inch OD
Air supply	1/2 inch OD
Bubbler drop pipes	3/4 inch

Buried piping 3/4 inch

8. Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

9. All digester gas piping shall be graded to points of drainage collection where drip legs and drip traps shall be provided. Drip traps are covered in the Digester Gas Control Equipment section.

10. Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

11. Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

12. Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

13. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

14. Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

15. Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation.

16. All chemical piping shall be installed so that lines are readily accessible for cleaning. Tees shall be provided at regular intervals in all chemical piping except chlorine piping, with extra openings plugged, to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of the plugs so that they can be easily removed. At each point where hose or reinforced plastic tubing is connected to rigid piping, a quick-disconnect coupling shall be provided.

17. Vent and gas piping for anhydrous ammonia, chlorine and sulfur dioxide gas shall be installed so that liquid traps are avoided. The open end of each vent line shall elbow down and shall be provided with a corrosion-resistant insect screen.

18. Double-contained chemical feed piping shall be installed according to the manufacturer's recommendations. Joints shall be solvent cemented. Splitting and rewelding of fittings will not be acceptable. Suitable drains and vents shall be provided to permit complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be designed to allow continuous drainage in the annular space to the drain

ports. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually inspected for leaks.

19. Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches above all portions of the buried pipe, but no more than 18 inches below the ground surface. Where the pipe extends above grade, a 2 foot length of wire shall be coiled and attached to the pipe.

20. Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.

21. Drains required for operation are shown on the Drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these Drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.

E. Reducers

1. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.

F. Valves

1. Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

3.4 PIPING ASSEMBLY

A. General

1. Contractor shall only use labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner

2. Any deviations from the Specifications or piping locations shown on the Drawings require prior review and approval by Engineer.

B. Buttwelded Piping

1. The specification and qualification of weld joints and welders for buttwelded piping shall be in accordance with ASME Boiler Pressure Vessel Code, Section IX, Welding and Brazing. Weld procedure specifications (WPS) and procedure qualification reports

(PQR) shall be submitted to Engineer for review and validation of joint design, efficiencies and strength before installation begins.

2. Nondestructive examination (NDE) shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section V, Nondestructive Examination. The minimum level of NDE shall be as follows:

   a. 100 percent visual examination of welds by a qualified examiner (per ASME B31.1), and
   b. Radiographic testing (RT) of 10 percent random sampling of welds.

3. If the Contractor wants to use alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to Engineer for review and approval at least 14 days before intended date of use.

4. Welding shall not begin until weld joint and welder qualification submittals have been reviewed and approved. NDE shall be performed before the pressure and leakage testing of the piping. Weld acceptance standards shall be in accordance with ASME B31.1, Chapter VI. If a weld fails the NDE, it shall be repaired and the test repeated at no additional cost to the Owner.

3.5 PROTECTIVE COATING

A. Standard weight steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.

B. Where specified in the Miscellaneous Steel Pipe, Tubing, and Accessories section, extra strong steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating or a shop applied tape wrap. Where not specified to be shop coated or wrapped in the Miscellaneous Steel Pipe, Tubing and Accessories section, a tape wrap shall be field applied. The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field.

C. All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils . Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.

D. Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar epoxy coating.

E. Inspection

1. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall

be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

2. The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3.6 PRESSURE AND LEAKAGE TESTING

A. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. The Contractor shall coordinate this section with the Pipeline Pressure and Leakage Testing section. Piping shall be tested at the indicated pressures:

Service	Test Pressure	Test Medium
Air Scour Piping (See paragraph 3.6.I)	10.4 PSIG	Compressed air with 100 percent of all oil 0.025 micron and larger removed
Water supply	1-1/2 times working pressure but not less than 120 psi	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi[	Compressed air
Compressed Air supply and signal (See paragraph 3.6.I)	1.2 times working pressure but not less than 50 psi	Compressed air with 100 percent of all oil 0.025 micron and larger removed
Liquid chlorine (pressure)	300 psi	Zero humidity air or nitrogen
Anhydrous ammonia gas (pressure)	300 psi	Zero humidity air or nitrogen
Chlorine gas (pressure)	300 psi	Zero humidity air or nitrogen
Sulfur dioxide gas (pressure)	300 psi	Zero humidity air or nitrogen
Chlorine gas (vacuum)	15 inches of mercury vacuum	Atmospheric air

Service	Test Pressure	Test Medium
Air Scour Piping (See paragraph 3.6.I)	10.4 PSIG	Compressed air with 100 percent of all oil 0.025 micron and larger removed
Sulfur dioxide gas (vacuum)	15 inches of mercury vacuum	Atmospheric air
Other piping	1-1/2 times working pressure but not less than 50 psi	Suitable fluid or gas; for distilled water piping, distilled water or filtered oil-free compressed air may be used

B. Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.

C. Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.

D. After completion of the specified pressure tests, all anhydrous ammonia, chlorine and sulfur dioxide gas piping shall be tested for leakage using the appropriate gas chemical at operating pressures. Piping shall be thoroughly cleaned and dried before admitting gas chemical into the system. Gas chemical shall be slowly admitted to the piping system.

E. For chlorine gas piping, leakage shall be checked by waving a swab soaked in aqua ammonia solution near each fitting. Ammonia solution shall not be applied directly to the fittings. Formation of white fumes will indicate the presence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.

F. Unless otherwise required by the applicable codes, drainage and venting systems shall be tested. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum pressure of 5 psig . Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

G. All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor. Contractor shall give Engineer 5 working days advanced notice of scheduled testing.

H. All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

I. Air Pressure Tests

1. Pressure tests shall be performed on all air piping systems as specified herein to conform to ASME B31.1.

2. The test pressure shall be as specified herein and shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, compressors, blowers, or valves, in the system. The pressure in the system shall gradually be increased to not more than one-half of the test pressure, after which the pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. The pressure shall be continuously maintained for a minimum duration of 10 min. It shall then be reduced to the blower rated discharge pressure held for such time as may be necessary to conduct the examination for leakage.

3. Examination for leakage detected by soap bubble or equivalent method shall be made at all joints and connections. The piping system, exclusive of possible localized instances at the compressor, blower, or valve packing, shall show no evidence of leaking.

4. Contractor shall be responsible for ensuring that all air piping is free of leaks. All joints which are found to be leaking shall be repaired and the test repeated.

3.7 CLEANING

A. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.

B. Metal anhydrous ammonia, chlorine and sulfur dioxide piping shall be cleaned as recommended by the gas chemical feed system supplier. All surfaces which may come into contact with gas chemical shall be thoroughly dry and free of oil or grease before being placed in service. The recommended cleaning procedures shall be submitted for review in accordance with the Submittals section.

C. Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3.8 ACCEPTANCE

A. Owner reserves the right to have any section of the piping system which he suspects may be faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in all directions until sound joints are found. Costs for replacement of faulty work and/or materials shall be the responsibility of Contractor.

End of Section

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SECTION 40 05 07 – PIPE SUPPORTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of pipe hangers, brackets, supports, bracing, anchorage, and the design for the pipe support system for pipes 12 inches and smaller. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in pipes 12 inches in diameter and smaller. Expansion joint products and materials are covered in the respective piping sections.

B. This section covers pipe supports for the following pipe materials:

1. Cast or ductile iron
2. Stainless Steel
3. Copper (hot water)
4. Copper (other)
5. PVC/CPVC Schedule 80 (chemical service)
6. PVC/CPVC Schedule 80 (other)
7. Polypropylene DWV
8. PVDF DWV
9. Cast iron soil pipe

1.2 GENERAL

A. Contractor shall provide pipe supports, anchors, flexible couplings, and expansion joints for all piping systems. The Drawings indicate pipe supports, anchors, flexible couplings, and expansion joints for pipes larger than 12 inches in diameter, and in special cases for pipes that are 12 inches and smaller. Contractor shall design anchors, pipe supports, expansion joints, and flexible couplings not already shown on the Drawings, in accordance with the requirements specified herein.

B. Contractor’s design shall include pipe supports, bracing, and anchorage adjacent to expansion joints, couplings, valves, in-line devices, equipment, wyes and tees, or changes in direction as required for dismantling piping, removing valves or other in-line devices, disconnecting piping

from equipment, and pipe support, in addition to supports in accordance with the maximum spacing specified herein. The pipe support system design by Contractor shall rigidly support pipe so there is no visible movement or visible sagging between supports. The system shall comply with specified piping code requirements.

C. Contractor shall not delete or relocate the supports, expansion joints, or couplings indicated on the Drawings without written approval of Engineer.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all supports furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

A. General Drawings and Data.

1. Complete data, catalog information, and drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper-plated and plastic-coated pipe supports shall be submitted in accordance with the Submittals Procedures section.

B. Intended Use and Location Schedule.

1. Data shall include a listing of the intended use and general location of each item submitted.

C. Meteorological and Seismic Certification.

1. When a wind and/or seismic design is required, Contractor shall submit confirmation of compliance with the Meteorological and Seismic Design Criteria section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58. Materials of construction for fabricated steel supports are covered in the Structural and Miscellaneous Metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

B. Unless otherwise specified or indicated on the Drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

C. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

D. Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches in length.

E. Unless accepted by Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be permitted.

F. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.

G. Supports for brass or copper pipe or tubing shall be copper plated or plastic coated.

H. Stainless steel supports shall be AISI Type 304 or 316 stainless steel, except for stainless steel supports fabricated by welding which shall be AISI Type 304L or 316L. Stainless steel supports shall be provided at all locations outdoors, submerged, or in a vault.

I. Hot-dip galvanized supports shall be in accordance with ASTM A153 and A385. Galvanized supports shall be provided at indoor locations.

J. Pipe support types and application shall comply with Table 1.

2.2 WIND AND SEISMIC LOADS

A. Wind and seismic loads for worst case conditions of either full, partially full, or empty pipes shall be considered in the design. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

PART 3 - EXECUTION

3.1 APPLICATION

A. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section.

B. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

C. When expansion joints are required, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as

expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the Drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for anchoring pipe against longitudinal forces. Pipe guides shall be provided at locations as recommended by the manufacturer.

D. Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.

E. Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.

F. When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3.2 TYPES OF SUPPORTS

A. The products for pipe supports shall be as indicated in Table 1 for the specified type and size of support. Where stainless steel is specified for pipe supports but is not available from the name suppliers for the model specified in Table 1, Contractor shall provide a heavier duty support that is available in stainless steel.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 58 Type (Note 1)	Specification
Hangers		
2-1/2 inch and smaller pipe		
For hot and cold insulated piping		
Clevis	1	B-Line “B3100,” Anvil “260” Piping Technology & Products Fig. 83.
Other services		
J-style	5	B-Line “B3690,” Anvil “67,” Unistrut “J Hanger,” or Piping Technology & Products Fig. 67.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 58 Type (Note 1)	Specification
Clevis	1	B-Line "B3104," Anvil "260," or Piping Technology & Products Fig. 83.
3 Through 12 inch pipe (Note 3)		
For hot insulated piping		
Double bolt	3	B-Line "B3144," Anvil "295," or Piping Technology & Products Fig. 70.
For cold insulated piping		
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
For uninsulated cold piping		
Clamp	4	B-Line "3140," Anvil "212," or Piping Technology & Products Fig. 50.
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
Other services		
Clevis	1	B-Line "B3100" or Anvil "260" for steel pipe; B-Line "B3102," Anvil "590," or Piping Technology & Products Fig. 83 C. L. for cast iron pipe.
Concrete Inserts, Steel		
12 inch and smaller pipe	18	Channel 12 ga , galv, 1-5/8 by 1-3/8 inches , min. 8 inches 200 mm long, anchor lugs on 4 inch centers, at least three lugs, end caps, and filler strip.
Beam Clamps, Malleable Iron or Steel, 12 inch and smaller pipe	21	B-Line "3050" and "3055," Anvil "133" and "134," or Piping Technology & Products Fig. 130 and Fig. 130 (SP).

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 58 Type (Note 1)	Specification
	28, 29	Anvil "292" or Piping Technology & Products Fig. 140.
	30	B-Line "3054," Anvil "228," or Piping Technology & Products Fig. 140.
Side Beam Bracket	34	B-Line "B3062," Anvil "202," or Piping Technology & Products Fig. 20L.
Wall Supports and Frames, Steel, 12 inch and smaller pipe (Note 2)		
Brackets	32	B-Line "B3066," Anvil "195," or Piping Technology & Products Fig. 76.
	33	B-Line "B3067," Anvil "199," or Piping Technology & Products Fig. 76.
Prefabricated channels	--	12 ga , galv, 1-5/8 inches , with suitable brackets and pipe clamps.
Offset pipe clamp, 1-1/2 inch and smaller pipe	--	Galv, 1-1/4 by 3/16 inch steel, with 3/8 inch bolts.
Offset pipe clamp, 2 to 3-1/2 inch pipe	--	Galv, 1-1/4 by 1/4 inch steel, with 3/8 inch bolts.
Floor Supports, Steel or Cast Iron		
6 inch and smaller pipe	37 (with base)	B-Line "B3090," Anvil "259" or Piping Technology & Products Fig. 48.
8 through 12 inch pipe	38	B-Line "B3093," Anvil "264" or Piping Technology & Products Fig. 46.
Pipe Alignment Guides	--	B-Line "B3281" through "B3287," Anvil "255," or Piping Technology & Products Fig. 6.
Turnbuckles Steel	13	B-Line "B3202," Anvil "230," or Piping Technology & Products Fig. 30.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 58 Type (Note 1)	Specification
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch minimum size	--	B-Line "B3205," Anvil "140," or Piping Technology & Products Fig. 128.
Weldless Eye Nut, steel	17	B-Line "B3200," Anvil "290," or Piping Technology & Products Fig. 40.
Insulation Protection Saddle	39	B-Line "B3160 Series," Anvil "160 Series," or Piping Technology & Products Fig. 184.
Insulation Protection Shield	40	B-Line "B3151," Anvil "167," or Piping Technology & Products Fig. 183.

Table 1 Notes:

1. MSS SP-58 supports and hangers are illustrated on Figure 1-15140.
2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.
3. Alternatively, pipe hangers for 12 inch pipe may be saddle type as indicated on the Drawings.

3.3 SUPPORT SPACINGS

A. Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The types of pipes to be supported are as specified herein. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0. Spacing in the tables is the maximum spacing considering gravity loads. Where Contractor's design includes lateral and longitudinal forces due to seismic loads, wind loads, and other forces, the spacing requirement may be less than that indicated in the tables.

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints

	feet	feet	feet	
Cast iron or Ductile iron	15	80	80	Note 6
Stainless steel				
1-1/4 inch and smaller	7	30	100	Note 3
1-1/2 to 4 inch	10	30	100	Note 3
Over 4 inch	15	80	80	Note 3
Copper, for hot water				
1 inch and smaller	5	20	100	Note 3
Over 1 inch	7	20	100	Note 3
Copper, for services other than hot water				
1 inch and smaller	5	--	--	Note 7
Over 1 inch	7	50	100	Note 3
PVC, Schedule 80, for alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution at a maximum temperature of 100° F .				
1/8 and 1/4 inch]	Continuous Support	20	60	Note 3
1/2 inch	3-1/2	20	60	Note 3
3/4 inch	4	20	60	Note 3
1 and 1-1/4 inch	4-1/2	20	60	Note 3
1-1/2 and 2 inch	5	20	60	Note 3
2-1/2 inch	5-1/2	20	60	Note 3
3 inch	6-1/2	20	60	Note 3
4 inch	7	20	60	Note 3
6 inch	8	20	60	Note 3
8 inch	9	20	60	Note 3
10 inch	9-1/2	20	60	Note 3
12 inch	10	20	60	Note 3
PVC, Schedule 80, for other services at a maximum temperature of 100° F and a maximum specific gravity of 1.0.				
1/8 and 1/4 inch	Continuous Support	20	60	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet	Expansion Joint Max Spacing (Note 2) feet	Type of Expansion Joints
1/2 inch	4	20	60	Note 3
3/4 inch	4-1/2	20	60	Note 3
1 and 1-1/4 inch	5	20	60	Note 3
1-1/2 and 2 inch	5-1/2	20	60	Note 3
2-1/2 inch	6	20	60	Note 3
3 inch	7	20	60	Note 3
4 inch	7-1/2	20	60	Note 3
6 inch	8-1/2	20	60	Note 3
8 inch	9-1/2	20	60	Note 3
10 inch	10	20	60	Note 3
12 inch	11	20	60	Note 3
PVDF DWV	6	--	--	Note 7
Cast iron soil pipe	10	--	--	Notes 7, 8

Table 2 Notes:

1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
3. Expansion joint fittings are specified in the respective piping sections.
4. At least two properly padded supports for each pipe section.
5. At least one support for each pipe section.
6. Expansion joints shall be mechanical couplings.
7. No expansion joints are required.
8. Supports for 5 and 10 foot long pipe sections shall be located within 18 inches of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.
9. References to specific gravity refer to liquid specific gravity and are referenced to water which is assumed to have a specific gravity of 1.0.

3.4 INSTALLATION

A. General

1. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, and adjacent to flexible couplings. Pipe supports and hangers shall not be installed in equipment access areas.

2. Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods when pipes are full. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

3. Where copper pipe is installed on a support system of dissimilar metal with other pipes, the copper pipe shall be galvanically isolated from the support using Neoprene strips or other material acceptable to Engineer.

4. No piping shall be supported from the pipe above.

5. Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

6. Anchorage shall be provided to resist both lateral and longitudinal seismic forces.

B. Inserts

1. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section. Reference building structural concrete Drawings for concrete inserts. When not provided as part of the building concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

2. Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.

3. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. NDE (Non-Destructive Evaluation) shall be used to locate existing reinforcing before drilling.

C. Pipe Hangers and Supports

1. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.

2. A hanger shall be placed within 18 inches of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 lbs or more.

3. Hangers shall have 1-1/2 inches minimum vertical adjustment.

4. Support horizontal cast iron, ductile iron and no-hub piping systems adjacent to each joint.

5. Support vertical piping at every floor using riser clamps.

6. Support riser piping independently of connected horizontal piping.

7. Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3.5 PLACEMENT

A. The maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2.

B. Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

C. Unless otherwise indicated on the Drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches out from the face of walls and at least 3 inches below ceilings.

End of Section

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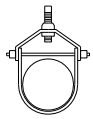
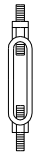


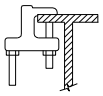
ADJ. STEEL CLEVIS
TYPE-1



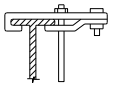
ADJ. STEEL
BAND HGR
TYPE-7



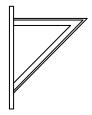
STEEL TURNBUCKLE
TYPE-13



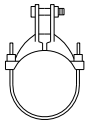
TOP BEAM
C-CLAMP
TYPE-19



TOP I-BEAM CLAMP
TYPE-25



LIGHT WELDED
STEEL BRACKET
TYPE-31



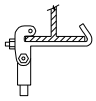
ALLOY STEEL
PIPE CLAMP
TYPE-2



EXTENSION PIPE ON
RISER CLAMP
TYPE-8



STEEL CLEVIS
TYPE-14



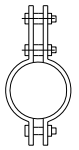
SIDE I-BEAM ON
CHANNEL CLAMP
TYPE-20



CLIP
TYPE-26

MEDIUM WELDED
STEEL BRACKET
TYPE-32

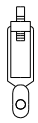
HEAVY WELDED
STEEL BRACKET
TYPE-33



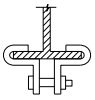
CARBON OR ALLOY
STEEL DOUBLE BOLT
PIPE CLAMP
TYPE-3



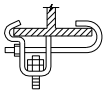
ADJUSTABLE
BAND HGR
TYPE-9



SWIVEL
TURNBUCKLE
TYPE-15



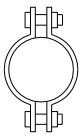
CENTER I-BEAM
TYPE-21



SIDE I-BEAM CLAMP
TYPE-27



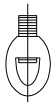
SIDE BEAM BRACKET
TYPE-34



STEEL PIPE CLAMP
TYPE-4



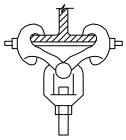
ADJ. SWIVEL RING
BAND TYPE
TYPE-10



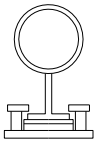
MALLEABLE
IRON SOCKET
TYPE-16



WELDED
ATTATCHMENT
TYPE-22
AS SHOWN OR
INVERTED LESS BOLT



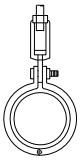
STEEL I-BEAM CLAMP
W/ EYE NUT
TYPE-28



PIPE SLIDE &
SLIDE PLATE
TYPE-35



PIPE HANGER
TYPE-5



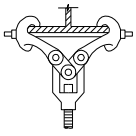
SPLIT PIPE W/WO
TURMBUCKLE ADJ.
TYPE-11



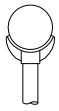
STEEL WELDLESS
EYE NUT
TYPE-17



C-CLAMP
TYPE-23



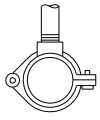
STEEL W.F. CLAMP
W/ EYE NUT
TYPE-29



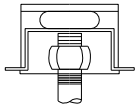
PIPE SADDLE
SUPPORT
TYPE-36



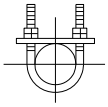
ADJ. SWIVEL PIPE RING
SPLIT RING TYPE OR
SOLID RING TYPE
TYPE-6



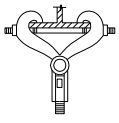
EXTENSION SPLIT
PIPE CLAMP
HINGED OR TWO BOLT
TYPE-12



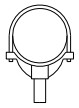
STEEL OR MALLEABLE
CONCRETE INSERT
TYPE-18



U-BOLT
TYPE-24



MALLEABLE BEAM CLAMP
W/EXTENSION PIECE
TYPE-30



PIPE STANCHION
SADDLE
TYPE-37

HANGERS AND SUPPORTS

Black & Veatch	PIPE SUPPORTS	FIG 1-40 05 07(A)

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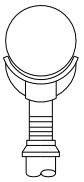
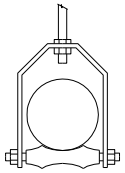
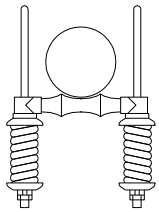


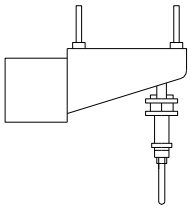
ADJUSTABLE PIPE
SADDLE SUPPORT
TYPE-38



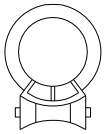
ADJUSTABLE ROLLER
HANGER W/WO SWIVEL
TYPE-43



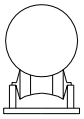
SPRING CUSHION ROLL
TYPE-49



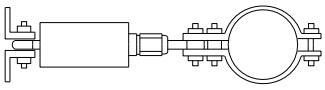
CONSTANT SUPPORT
HORIZONTAL TYPE
TYPE-54



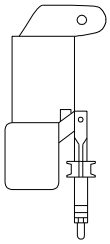
STEEL PIPE COVER
PROTECTION SADDLE
TYPE-39



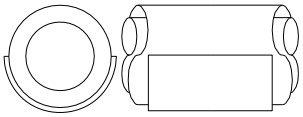
PIPE ROLL
COMPLETE
TYPE-44



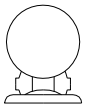
SPRING SWAY BRACE
TYPE-50



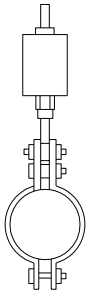
CONSTANT SUPPORT
VERTICAL TYPE
TYPE-55



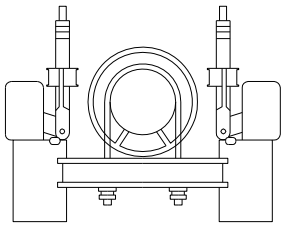
PROTECTION SHIELD
TYPE-40



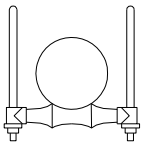
PIPE ROLL & PLATE
TYPE-45



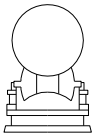
VARIABLE SPRING
HANGER
TYPE-51



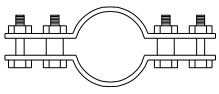
CONSTANT SUPPORT
TRAPEZE TYPE
TYPE-56



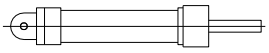
SINGLE PIPE ROLL
TYPE-41



ADJUSTABLE PIPE ROLL & BASE
TYPE-46



CARBON OR ALLOY STEEL
RISER CLAMP
TYPE-42



RESTRAINT CONTROL
DEVICE
TYPE-47



VARIABLE SPRING
BASE SUPPORT
TYPE-52

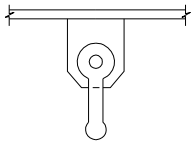
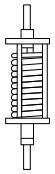
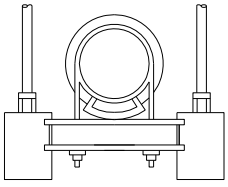


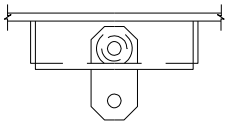
PLATE LUG
TYPE-57



SPRING CUSHION
TYPE-48



VARIABLE SPRING
TRAPEZE HANGER
TYPE-53



HORIZONTAL TRAVELER
TYPE-58

HANGERS AND SUPPORTS

Black & Veatch	PIPE SUPPORTS	FIG 1-40 05 07(B)

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SECTION 40 05 17 -- COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of copper tubing and accessories. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

B. Refer to section 40 42 11 – Mechanical Insulation for insulation materials and jacketing.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

   a. Name of Manufacturer
   b. Type and model
   c. Construction materials, thickness, and finishes
   d. Pressure and temperature ratings

B. Gasket Material Certification.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper tubing materials and service shall be as specified herein.

B. Material Classification CU-1

CU-1 – Water Tubing with Flared Fittings Buried water supply, 2 inch and smaller. All instrument tubing not otherwise specified.	Tubing Fittings	Soft annealed copper tubing, ASTM B88, Type K. Flared, material to match tubing. Fittings shall conform to ANSI/ASME B16.26.

C. Material Classification CU-2

CU-2 – Water Tubing with Brazed Joints Buried water supply, 2-1/2 and 3 inch .	Tubing Fittings	Hard drawn copper tubing, ASTM B88, Type K. Brazed joint, material to match tubing. Fittings shall conform to ANSI B16.18 or ANSI/ASME B16.22.

D. Material Classification CU-3

CU-3 – Water Tubing with Solder and Brazed Joints Potable, non-potable, and plant effluent water supply, 3 inch and smaller. Hot water supply. Compressed air, in-plant and exposed.	Tubing Fittings Flanges	Hard drawn copper tubing, ASTM B88, Type L. Solder joint (smaller than 2 inch except compressed air piping), Brazed joint (2 inch and larger for piping other than compressed air and all sizes for compressed air piping), material to match tubing. Fittings shall conform to ANSI B16.18, or ANSI/ASME B16.22. Where required for connection to equipment, valves, and accessories, ANSI B16.24, class 150, cast bronze, brazed joint.

E. Material Classification CU-4

CU-4 – Air Tubing with Solder and Brazed Joints Buried or submerged compressed air supply piping. Liquid oxygen.	Tubing Fittings	Soft annealed copper tubing, ASTM B88, Type K. Solder joint (smaller than 2 inch except liquid oxygen), Brazed joint (any size), material to match tubing. Fittings shall conform to ANSI B16.18, or ANSI/ASME B16.22.

F. Material Classification CU-5

CU-5 – Chemical Feed Tubing with Union Fittings Chlorine container flexible connection. Sulfur dioxide container flexible connection.	Tubing Fittings	Soft annealed copper tubing, ASTM B88, Type K, cadmium plated for chlorine services. Union type with nonmetallic gasket or chemical lead alloy gasket containing 2 to 4 percent antimony. Fittings shall be brazed to tubing.

G. Material Classification CU-6

CU-6 – Instrument Tubing with Compression Fittings Panel mounted compressed air piping, 3/4 inch and smaller. Instrument air piping 3/4 inch and smaller.	Tubing Fittings	Soft annealed copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280. Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".

H. Material Classification CU-7

CU-7 – ACR Tubing with Brazed Fittings Refrigerant piping.	Tubing Fittings	Hard drawn ACR copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280. Brazed.

I. Material Classification CU-8

CU-8 – Hydraulic Tubing with Compression Fittings Indicate services	Tubing Fittings	ASTM B75, seamless, soft annealed, wall thickness as required. Tubing size: Insert size Required wall thickness: Insert thickness Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".

J. Accessory Materials

1. Accessory materials for the copper tubing systems shall be as indicated.

Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch thick.

Expansion Joints	Tempflex "Model HB Expansion Compensators" with copper tube ends.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, poly-propylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 40 05 19 - DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of ductile iron pipe. Ductile iron pipe shall be furnished complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasement, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.

B. Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment furnished by Owner or others for installation under this Contract.

C. Pipe hangers and supports, pressure and leakage testing, and cleaning and disinfection are covered in other sections. Cast iron soil pipe is covered in the Cast Iron Soil Pipe and Accessories section. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1.2 GOVERNING STANDARDS

A. Except as modified or supplemented herein, all ductile iron pipe, fittings, and specials shall conform to the applicable requirements of the following standards and other standards named in this section:

ANSI/AWWA Standards	Title
C151	Ductile-Iron Pipe, Centrifugally Cast, For Water
C600	Installation of Ductile Iron Water Mains and Their Appurtenances
M41	Ductile Iron Pipe and Fittings - Manual of Water Supply Practices
C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings
C105	Polyethylene Encasement for Ductile Iron Pipe Systems
C110	Ductile-Iron and Gray-Iron Fittings
C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

ANSI/AWWA Standards	Title
C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
C153	Ductile-Iron Compact Fittings

1.3 PIPE MANUFACTURER AND FIELD SERVICES

A. All ductile iron pipe, fittings, specials, bolts, gaskets, other jointing materials, and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer responsibilities, which shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials, and pipe appurtenances (except for furnished coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified test pressures and service conditions; ensuring and certifying that all pipe, fittings, specials, and other pipe materials, pipe gaskets and bolts specified herein, are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.

B. The pipe manufacturer's minimum required experience qualifications shall include:

1. Manufacture of interior and buried plant piping of similar diameters of at least two water or wastewater plants with joints, linings, and coatings suitable for the same or higher pressure rating,

2. A pipeline at least 1 mile in length, of a diameter equal to or larger than the pipe to be provided, with joints, lining, and coating suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.

C. All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations.

1.4 SUBMITTALS

A. General Submittals.

1. Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the submittals listed in this section.

B. Experience Certification

1. Certification of pipe manufacturer's experience requirements

C. ANSI/AWWA Certification

1. Certification by manufacturer (affidavit of compliance) for each item furnished in accordance with the ANSI/AWWA Standards.

D. Restrained joints details.

E. Emergency Repair Contact Info

1. Relevant contact information for emergency repair assitance, including names and telephone numbers of emergency contact persons.

F. Gasket Certifications

1. Certification of gaskets by pipe manufacturer, certifying that gasket material is suitable for test pressures and services intended.

G. ANSI/NSF 61 and ANSI/NSF 600 Certification.

1. Certification that all materials in contact with treated or potable water are ANSI/NSF 61 and ANSI/NSF 600 approved.

H. Certification of Joint Lubricant.

I. Joint Test Certification

1. Certification of proof-of-design tests for joints, including restrained joints.

J. Welded-on Outlet Certification

1. Certification of proof-of-design tests for welded-on outlets and experience documentation. Air test documentation for the welded-on outlets used for this project.

K. Ground Elevation and Utility Locations:

1. Prior to preparation of the pipe laying schedule, Contractor shall verify the existing ground elevation and the location and depth of all underground utilities using centerline stakes set at no more than 100 feet intervals. Contractor shall carefully locate and excavate utility, survey, document and submit this information to the Engineer.

2. Engineer will review this information and if necessary make adjustment to the pipeline profile. Any plans sheets that are modified by the Engineer will be reissued to the Contractor.

L. Deflection Measurement

1. The method that the Contractor proposes to use for measuring deflection of pipe joints.

M. Other Data

1. Submittal data shall clearly indicate the country of origin of pipe, fittings, flanges, restraining devices, and accessories. When requested by Engineer, certified copies of physical and chemical test results as outlined in ANSI/AWWA C151/A21.51 shall be submitted for the materials to be provided.

1.5 SHIPPING, HANDLING, AND STORAGE

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

B. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining if such lining is specified.

C. Contractor-furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.

PART 2 - PRODUCTS

2.1 PIPE CLASS

A. The class of ductile iron pipe shall be as indicated in the following table for those services indicated in the on the Drawings. The specified class includes service allowance and casting allowance.

Pipe Size		ANSI/AWWA Pressure Class
inches	mm	
64 thru 30	1600 thru 750	150
24 thru 14	500 thru 350	250
12 and smaller	300 and smaller	350

B. Pipe wall thickness for grooved and threaded end pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size		Minimum Thickness Class	
inches	mm	Threaded Ends (1)	Grooved Ends (2)
4-16	100-400	53	53
18	450	53	54
20	500	53	55

24	600	53	56
30-54	750-1400	53	--
60 and 64	1500-1600	350 (3)	--

(1) Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

(2) Complies with ANSI/AWWA C606 for grooved and shouldered joint ductile iron pipe.

(3) Minimum class for 60 and 64 inch pipe is pressure class 350.

2.2 MATERIALS

Pipe	Ductile iron, ANSI/AWWA C151/A21.51
Gaskets – All Joint Types	Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer unless another manufacturer's product is indicated. Pipe manufacturer shall submit certificates of gasket suitability certifying that the gasket materials are compatible with the joints specified, are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall be certified for chlorinated and chloraminated potable water. Gas and oil-resistant gaskets shall be made of Nitrile (NBR [Acrylonitrile Butadiene]) rubber. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.
Joint Lubricant	Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal-based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61 and ANSI/NSF 600.
Fittings	ANSI/AWWA C110/A21.10 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the Drawings.

Fitting Size, inches	Material	Type	Min. Working Pressure Rating, psi
4 to 24	DI	Mechanical and Push-on joints	350
4 to 24	DI	Flanged joints	250
30 to 48	DI	All joints	250
54 to 64	DI	All joints	150

All fittings shall be ductile iron and suitable for the rated working pressure plus a surge or test pressure allowance of 100 psi or 1.5 times rated working pressure, whichever is less, without leakage or damage.	
Push-on Joints	ANSI/AWWA C111/A21.11
Restrained Push-on Joints, gaskets with stainless steel gripping segments, 4 inch through 12 inch , working pressure rating 350 psi .	American “Fast Grip.” U.S. Pipe "Field Lok 350 Gasket", or McWane Sure Stop 350 Gasket.
Restrained Push-on Joints, locking wedge type, 4 inch through 24 inch , working pressure rating 350 psi for 4 through 16 inch and at least 250 psi for 18 through 24 inch.	EBAA Iron "Megalug" Series 1700; U.S. Pipe “TR Flex Gripper Ring”; Star Pipe Products “StarGrip 3100P”; or American “Field Flex Ring”, without exception.
Restrained Push-on Joints, positive locking segments and/or rings, 4 inch through 24 inch , working pressure rating 350 psi .	American "Flex-Ring,"; U.S. Pipe “HDSS”; or McWane "TR Flex."
Restrained Push-on Joints, positive locking segments and/or rings, 30 inch through 48 inch , working pressure rating at least 250 psi .	American "Flex-Ring," or "Lok Ring"; U.S. Pipe or McWane "TR Flex"; U.S. Pipe “HP LOK” or “HDSS”.
Restrained Push-on Joints, positive locking segments and/or rings, 54 inch thru 64 inch , working pressure rating at least 250 psi .	American "Lok Ring"; or U.S,Pipe “H.P. LOK.”
Restrained push-on joints shall be suitable for a test or working pressure plus surge pressure of the rated working pressure plus 100 psi	
Flanged Joints	ANSI/AWWA C115/A21.15
Flanges	
Class 250 (Where identified on the Drawings)	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.
All others	Ductile iron, Class 125, ANSI/AWWA C115/A21.15.
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut.

Nuts	ASTM A563, hexagonal, ANSI/ASME B18.2.2, heavy semifinished pattern.
Gaskets	ASTM D1330, Grade I rubber, full face type, 1/8 inch thick unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Insulated Flanges	
Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Advanced Products or Pipeline Seal and Insulator, Inc.
Insulating Gaskets	Type E, G-10, 1/8 inch thick, with Nitrile or EPDM sealing element for water and air service and Viton sealing elements for wastewater service unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Bolt Insulating Sleeves	G-10, 1/32 inch thick.
Insulating Washers	G-10, 1/8 inch thick, two for each flange bolt.
Backing Washers	Steel, 1/8 inch thick, two for each flange bolt.
Mechanical Joints	ANSI/AWWA C111/A21.11, with ductile iron glands
Restrained Mechanical Joints (factory prepared spigot), 4 inch through 48 inch , working pressure rating at least 250 psi .	American "MJ coupled Joints," or Griffin U.S. Pipe "Mech-Lok." (thru 36” size only)
Restrained Mechanical Joints, (field cut spigot), 4 inch through 24 inch , working pressure rating 350 psi for 4 through 16 inch and at least 250 psi for 18 through 24 inch.	EBAA Iron "Megalug" Series 1100, Sigma “One Lok” SLDE series, or Star Pipe Products “StarGrip 3000” without exception.
Restrained mechanical joints shall be suitable for a test or working pressure plus surge pressure of the rated working pressure plus 100 psi	

Wall Pipes or Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron pipe; holes sized in accordance with the details on the Drawings and provided with removable plugs.
Mechanical Joints with Tie Rods	As indicated in the Drawings.
Tie Rods	ASTM A307.
Steel Pipe	ASTM A53, Schedule 40 or 80 as indicated on the Drawings.
Washers	ANSI/ASME B18.22.1, plain steel.
Threaded Connections	ANSI/ASME B1.20.1, NPT; with boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.
Mechanical Couplings	
Couplings	Dresser "Style 38"; Smith-Blair "411 Steel Coupling"; or Romac “Style 400” or "Style 501"; without pipe stop.
Gaskets	Oil-resistant synthetic rubber gaskets shall be as recommended by the coupling manufacturer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Restrained Mechanical Couplings	American Pipe “Restrained Coupling Gland Joint” coordinated with mechanical couplings furnished.
Grooved End Joints	AWWA C606.
Pipe Ends (rigid joints)	Grooved, with dimensions conforming to AWWA C606, Table 3.
Pipe Ends (flexible joints)	Shouldered, with dimensions conforming to AWWA C606, Table 4.
Couplings (non-shouldered pipe)	Tyco/Grinnell “Figure 772,” or Victaulic “Style 31.”
Couplings (shouldered pipe)	Victaulic “Style 41” or “Style 44.”

Flanged Coupling Adapters	
Restrained 4 inch through 12 inch . Unless otherwise indicated on the Drawings, flanged coupling adapters shall be restrained.	Smith-Blair "Type 912" or Romac "Style FCA501", with anchor studs of sufficient size and number to withstand test pressures.
Unrestrained 14 inch and larger	Smith Blair "Type 913" or Romac "Style FC400."
Dismantling Joints	
Restrained 3 inch and larger Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.	Romac "DJ400"; Dresser "Style 131 Dismantling Joint" or Viking Johnson. For use in potable water systems, coating to be in accordance with NSF-61 and ANSI/NSF 600.
Tapping Saddles	Ductile iron, with stainless steel straps and synthetic rubber sealing gasket, 250 psi pressure rating.
Watertight/Dusttight Pipe Sleeves	GPT " Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and stainless steel bolts and nuts.
Shop Coating and Lining	
Cement Mortar Lining with Seal Coat	ANSI/AWWA C104/A21.4.
Protective Fusion-Bonded	ANSI/AWWA C116/A21.16.
Ceramic Epoxy Lining	Induron “Protecto 401 Ceramic Epoxy.”
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 10 mils , Mohs’ Hardness 5 to 6 density as determined by ASTM D792; U.S. Pipe Fast Fabricators, Inc. "MEH 32" or "SG-14.”, or C&B Piping “CBGL911”
Universal Primer	Manufacturer’s standard. If in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61 and ANSI/NSF 600.
Asphaltic Coating	Manufacturer’s standard.
Zinc Coating	ISO 8179.

Coal Tar Epoxy	Manufacturer's standard.
Liquid Epoxy	ANSI/AWWA C210, non-coal tar modified, or when in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61 and ANSI/NSF 600.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize."
Corrosion Protection	
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLDPE - 8 mil or HDCLPE - 4 mil .
Heat-shrinkable Coating and Primer (Shrink Sleeve)	ANIS/AWWA C216, cross-linked polyethylene sheeting precoated with adhesive; minimum 80 mils; type and recovery as recommended by Shrink Sleeve manufacturer; Canusa-CPS or Berry Plastics Water Wrap.
Wax Tape and Primer	ANSI/AWWA C217, cold-applied petroleum wax primer and cold-applied petroleum wax tape; Trenton Wax-Tape and Primer.
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46 465 H.B. Tnemecol."

2.3 OUTLETS

A. Where a 12 inch or smaller branch outlet is indicated and the diameter of the parent pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.

B. Welded-on outlets shall be fabricated by the pipe manufacturer at its production facilities. Manufacturers of welded-on outlets shall have at least 5 years of satisfactory experience in the manufacture and performance of these products. The manufacturer shall have a documented welding quality assurance system and shall maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall also maintain appropriate welding procedure specifications (WPS) and procedure qualification (PQR), and welder performance qualification (WPQR) records.

C. The type of pipe end for the branch outlet shall be as specified or indicated on the Drawings. The maximum size and laying length of the welded-on branch outlet shall be as recommended

by the pipe manufacturer and shall be acceptable to Engineer for the field conditions and the connecting pipe or valve.

D. At locations acceptable to Engineer, drilling and tapping of the pipe wall for 2 inch and smaller pipe connections will also be acceptable, provided that the wall thickness, minus the casting allowance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A of ANSI/AWWA C151/A21.51

2.4 JOINTS

A. Joints in buried and tunnel locations shall be mechanical or push-on type unless otherwise indicated on the Drawings or where required to connect to existing piping or to valves. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the Drawings.

B. Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure rating of the joint. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design. Any new proof-of-design testing to meet the requirements for this project shall be independently verified and the Owner shall be given the opportunity to witness the testing.

C. Unless otherwise indicated on the drawings or acceptable to the Engineer, field closure pieces shall be located away from the bends or dead ends beyond the length over which joints are to be restrained.

D. All joints shall be restrained.

E. Flanged Joints

1. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

F. Flanged Coupling Adaptors

1. Flanged coupling adapters shall be provided for restrained couplings 12 inch and smaller where indicated on the Drawings and as specified herein. Unless indicated otherwise on the Drawings, all flange coupling adapters 12 inch and smaller shall be restrained. Flange coupling adapters 14 inch and larger may only be used in unrestrained pipe applications.

2. The inner and outer surfaces of couplings, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be

shop coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

G. Dismantling Joints

1. Dismantling joints shall be provided for restrained couplings 6 inch and larger piping where indicated on the Drawings and as specified herein. Dismantling joints shall comply with AWWA C219 and shall be restrained flange by flange couplings manufactured as a single unit. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.The inner and outer surfaces of dismantling joints, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be shop coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

H. Mechanical Couplings

1. The piping layout for mechanical couplings shall provide a space of at least 1/4 inch , but not more than 1 inch , between the pipe ends.

2. All surfaces, including the interior surfaces of the middle rings, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall be shop coated with 16 mils liquid epoxy in accordance with ANSI/AWWA C210.

3. A ductile iron pipe factory spacer shall be provided for the piping where indicated on the drawings. The spacer shall be shop lined and coated with 16 mils of liquid epoxy. Piping surfaces within the coupling shall be shop coated with 16 mils of liquid epoxy.

4. Tie bolts shall be provided to restrain mechanical coupling connections where indicated on the Drawings. The connecting pipe shall be furnished with welded retainer rings as recommended by pipe manufacturer. The pipe manufacturer shall also coordinate the restrained connection with the pressure rating, length, and diameter dimensions of the mechanical coupling being furnished to assure proper clearance is provided for completing the restrained coupling installation.

I. Grooved-End Couplings

1. Grooved-end couplings shall not be used in the following applications: chemical service, except lime slurry piping, flammable liquid or flammable gas piping, compressed air or compressed gas piping operating at pressures above 25 psig , toxic gas piping, hot liquid with operating temperatures above 120°F , or steam piping.

2.5 REDUCERS

A. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

2.6 BLOWOFFS

A. Each blowoff shall be located and arranged as indicated on the Drawings.

2.7 ACCESS OPENINGS

A. Access openings shall be installed at the locations indicated on the Drawings. Access openings shall be 36 inch diameter outlets for 36 inch and larger diameter pipe and the same size as the pipe for 24 and 30 inch diameter pipe. Access openings shall be provided with either flanged outlets with blind flange cover or mechanical joint outlets with restrained mechanical joint plugs. Unless otherwise indicated on the Drawings or acceptable to the Engineer, covers shall be designed for the same external loads and internal pressures as the adjacent pipe. Covers shall be fabricated from steel plate and shall have two handles fabricated from 1 inch diameter rod or shall be manufacturer's standard blind flange with integrally cast lifting devices, either one in the center or two or more symmetrically located around the perimeter of the cover. At the option of the Contractor, and if acceptable to the Engineer, reinforced or dished covers of lighter weight and equal strength may be provided.

2.8 WALL AND FLOOR PIPES

1. Wall and floor pipes shall be installed where ductile iron pipes pass through concrete walls or floors, unless otherwise indicated on the Drawings.

2. Where a flange and mechanical joint pipe piece is to connect to a mechanical joint wall pipe or casting, the bolt holes in the bell of the wall pipe or casting shall straddle the top centerline of the horizontal pipe or casting and shall align with the bolt holes in the flange and mechanical joint piece. The top centerline shall be marked on the wall pipe or casting at the foundry or fabrication shop.

3. In vertical piping, the bolt holes of flanged and mechanical joint floor pipes or castings shall be aligned with the bolt holes of the flange or mechanical joint connecting piece. The required centerline alignment and orientation of the floor pipe or casting shall be marked on the floor pipe or casting at the foundry or fabrication shop.

2.9 WALL AND FLOOR SLEEVES

A. Wall and floor sleeves shall be installed where indicated on the Drawings and shall be installed where ductile iron pipe passes through concrete walls and floors or masonry walls, unless otherwise noted. To minimize sleeve size, piping on either side of the sleeve shall be provided with a screw-on flange, grooved coupling, or mechanical coupling with anchor studs to allow the pipe to pass through the sleeve. Where required, sleeves in masonry walls may be enlarged enough for flange or other joint restraint to pass through the sleeve.

B. Where specified or indicated on the Drawings, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall or floor sleeves with the modular casing seal manufacturer.

When soil may be present at wall sleeves, two sets of modular casing seals shall be installed, one at each face of the wall. Unless otherwise indicated on the Drawings, modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inch size.

2.10 SHOP COATING AND LINING

A. The interior of all pipe and fittings, unless noted otherwise, shall be cement mortar lined.

B. Lining for pipe and fittings for gravity sewers and wastewater facilities services shall be as specified below:

Service	Lining
Gravity sewers	Coal tar epoxy.

C. The exterior surfaces of all pipe and fittings which will be exposed in both interior and exterior locations shall be shop primed. Field painting of exposed exterior surfaces is covered in the Protective Coatings section. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

2.11 OWNER'S SHOP INSPECTION AND TESTING

A. Tests for preliminary acceptance of materials and methods of manufacture shall be made at the expense of the Contractor. At the Owner's option, inspection and control tests during manufacture of the pipe to be provided under this Contract may be made by representatives of the Owner. The manufacturer and the Contractor shall provide facilities, space, and assistance for testing and the Owner's representative shall have free access to all parts of the plant involved in the furnishing of materials under this Contract.

B. Prior to the start of fabrication of the pipe, the Contractor shall submit the manufacturer's fabrication schedule covering each stage of the fabrication of the pipe. A fabrication schedule shall be submitted to Owner at least 30 days prior to fabrication activities. Each time the schedule is changed, the Contractor shall revise and resubmit the schedule. The Contractor shall notify the Engineer at least 3 days prior to any change in the revised and current schedule. If the Owner's representatives make an inspection and the manufacturer is not performing the work as indicated in the revised and current schedule for that date, the expense shall be the sole responsibility of the Contractor.

C. The Owner's representatives may reject any material which is not applied or fabricated in accordance with the Contract Documents, and which does not attain the prescribed test results. The expense of all subsequent tests, due to failure of original materials and fabrication to comply with the Contract Documents, shall be the sole responsibility of the Contractor.

D. Inspection and testing by the Owner's representatives are for the sole benefit of the Owner. Inspection by the Owner's representatives, or Owner’s decision not to provide inspections, shall not relieve the Contractor of his responsibility to provide materials and perform the work in accordance with the Contract Documents.

E. The Owner's expense for any reinspections due to failure of original materials and fabrication to comply with the Contract Documents or for any inspection trip that was made when work was not being performed as indicated in the current schedule, will be deducted from the Contractor's pay estimate.

F. The Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to meet with the specified requirements.

PART 3 - EXECUTION

3.1 INSPECTION

A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site.

3.2 PROTECTION AND CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work is completed. Before jointing, all joint contact surfaces shall be wire brushed if necessary and wiped clean.

B. Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

C. Whenever pipe laying is stopped, the open end of the pipe shall be closed to prevent entry of dirt, mud, rodents, and other material. All water in the trench shall be removed prior to removing the closure.

3.3 CUTTING PIPE

A. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or a power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

B. All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

C. Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be acceptable. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be acceptable.

D. Contractor shall use factory prepared pipe ends unless a field cut is required for connections.

3.4 ALIGNMENT AND GRADE

A. Buried piping shall be laid to the lines and grades indicated on the Drawings and as specified. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated for full-length push-on joint pipe for full-length mechanical joint pipe of AWWA C600, unless specially designed bells and spigots are provided. Contractor shall submit his proposed methods to measure deflection of deflected joints in accordance with the Submittal section.

B. Whenever deflections would exceed the values stipulated in AWWA C600, either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the Drawings and as acceptable to the Engineer.

C. Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

D. Additional requirements for alignment and grade are covered in the Project Requirements and Trenching and Backfilling sections and on the Drawings.

E. Tolerances

1. Each section of pipe shall be laid to the alignment and grade indicated on the Drawings and pipe laying schedule with pipe ends within the following tolerances;

    a. +/- 0.10 foot in grade at any point
    b. +/- 0.20 foot in alignment at any point

2. In addition, piping shall be visually straight or on a smooth curve between the points of defection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances,to make connections to existing pipe, to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

3.5 LAYING PIPE

A. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material installed as specified in the Trenching and Backfilling section. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of outlets and fittings to hold the pipe in proper position and alignment during the subsequent pipe jointing, embedment, and backfilling.

B. Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is specifically acceptable to Engineer.

C. The pipe laying schedule shall be annotated during the progress of the work to show all changes made during construction for record documentation. Upon completion of the installation of the piping, the annotated pipe laying schedule shall be submitted to Engineer in accordance with the Submittals Procedures section.

3.6 JOINTS

A. Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly. Restrained joints shall be extended after they are assembled to minimize further take-up.

3.7 MECHANICAL JOINTS

A. Mechanical joints shall be carefully assembled in accordance with the pipe manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be acceptable.

B. The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top centerline for horizontal piping.

3.8 PUSH-ON JOINTS

A. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with a soap solution provided by the pipe manufacturer immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

B. Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3.9 FLANGED JOINTS

A. When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern and at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer's recommendations.

B. Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges before any bolts are installed in the flanges.

C. Pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.

D. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

E. Insulated Flanged Joints

1. Insulated flanged joints shall be installed where indicated on the Drawings. In addition to one full-faced insulated gasket, each flange insulating assembly shall consist of one full-length sleeve, two insulating washers, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the insulating kit manufacturer.

3.10 FLANGED COUPLING ADAPTERS

A. Flange coupling adapters shall be installed in accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch larger than the diameter of the stud projection. Unless indicated on the Drawings, all flange coupling adapters shall be restrained.

3.11 DISMANTLING JOINTS

A. Dismantling joints shall be installed in accordance with the coupling manufacturer's recommendations.

3.12 MECHANICAL COUPLINGS

1. Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch , but not more than 1 inch , shall be left

between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

3.13 GAS AND OIL-RESISTANT GASKETS

A. Gas and oil-resistant gaskets shall be installed where specified, indicated on the Drawings, or directed by Engineer where jointing gaskets may be subject to permeation when piping passes through areas where soil may be contaminated with gas or petroleum (oil) products or organic solvents or their vapors.

3.14 CORROSION PROTECTION

A. Polyethylene Encasement

1. All buried pipe including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, shall be provided with at least one wrap of polyethylene encasement. Other locations where ductile iron pipe and accessories shall be double wrapped with polyethylene encasement shall be as specified herein and as indicated on the Drawings. Where ductile iron pipe is also embedded or encased in concrete, including in locations beneath structures, the polyethylene encasement shall be installed around the pipe for 5 feet extending into each end of the concrete encasement.

2. Where the ductile iron pipe is embedded within a concrete structure wall, floor or footing, the polyethylene encasement for the pipe shall end at the outside faces of the structure. Ductile iron pipe embedded within concrete structures shall not be wrapped with polyethylene encasement.

3. All buried flanged valves, mechanical joint couplings with tie rods, mechanical couplings, restrained mechanical couplings and other pipe harness assemblies at valves or structure walls shall be provided with two wraps of polyethylene encasement in addition to other corrosion protection coatings as specified herein.

4. Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Preparation of the pipe shall include, but shall not be limited to, removal of lumps of clay, mud, cinders, etc., prior to installation.

5. The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

    a. Inspection and Testing
        1) Tests for preliminary acceptance of polyethylene encasement materials as required in the submittal paragraph shall be made at the expense of the Contractor.

2) At the Owner's expense, the Owner may obtain samples from the material supplied in the field and have test conducted of the requirements specified in ANSI/AWWA C105/A21.5 by an independent third-party laboratory.

B. Mechanical Joint Couplings with Tie Rods

1. The mechanical joint tie rods, bolt studs, pipe spacers and washers of buried mechanical joint couplings as detailed on the Drawings shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following application of the wax tape protection, the entire mechanical joint coupling assembly shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the coupling assembly.

C. Flanged Joints

1. The flange bolts and nuts on buried flanges, including valve flanges, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following application of the wax tape protection, the entire flanged joint shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement on each side of the joint.

D. Valves

1. Buried portions of the valve and the actuator to the wrench nut shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the valve.

E. Mechanical Couplings

1. The tie bolts and nuts on all buried mechanical couplings shall be coated with two coats of medium consistency coal tar.

2. After the protective coating has been applied to the tie bolts, the entire mechanical coupling shall be encapsulated with a shrink sleeve **[**as indicated on the Drawings**]**. The shrink sleeve shall extend a minimum of 6 inches on to the pipe on each side of the coupling. A primer shall be applied to the piping on each side of the coupling prior to installing the shrink sleeve. The application of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces. Following installation of the shrink sleeve, the entire

assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

F. Restrained Mechanical Couplings

1. The corrosion protection for the mechanical coupling and its tie bolts and nuts of all buried restrained mechanical coupling assemblies shall be protected with two coats of medium consistency coal tar and shrink sleeve as specified herein for buried mechanical couplings.

2. The tie rods and bolts of the coupling assembly shall be protected by wrapping them with wax tap in accordance with ANSI/AWWA C217**[** and as detailed on the Drawings**]**. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

3. Following the application of the wax tape, the entire restrained mechanical coupling assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

G. Other Assemblies

1. All ferrous metal clamps, tie rods, bolts, and other components of buried joint harnesses, tapping saddles, or pipe reaction anchorages in contact with earth or other fill material and not encased in concrete, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following the application of the wax tape, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

H. Surfaces Exposed in Manholes and Vaults

1. Unless otherwise specified, all uncoated surfaces exposed in manholes and vaults shall be cleaned and coated with two coats of medium consistency coal tar. The first coat shall be dry and hard before the second coat is applied. There shall be no unprotected, bare, or uncoated ferrous metal surfaces.

3.15 CONNECTIONS WITH EXISTING PIPING

A. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

B. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then all connections with potable water pipelines shall be cleaned and disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

3.16 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed where indicated on the Drawings. A pipe joint shall be provided within 12 inches of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.17 REACTION ANCHORAGE AND BLOCKING

A. Concrete blocking shall be installed where indicated on the Drawings. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section.

B. The blocking size shall be of the dimensions indicated on the Drawings, shall extend from the fitting to solid, undisturbed earth, and shall be installed so that all joints are accessible for repair. If adequate support against undisturbed ground cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

C. Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as indicated on the Drawings.

D. All ferrous metal clamps, rods, bolts, and other components of tapping saddles, reaction anchorages, or joint harness, subject to submergence or in contact with earth or other fill material and not encased in concrete, shall be protected from corrosion as specified in the Corrosion Protection paragraph of this section.

3.18 PRESSURE AND LEAKAGE TESTS

A. After installation, pipe and fittings shall be subjected to a pressure test and a leakage test in accordance with the Pipeline Pressure and Leakage Testing section.

B. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.

C. All joints shall be watertight and free from visible leaks. Any visible leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.19 CLEANING AND DISINFECTION

A. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean of any foreign matter until the work has been accepted. All joint contact surfaces shall be kept clean until the joint is completed.

B. After installation, all potable water pipelines shall be cleaned and disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

End of Section

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SECTION 40 05 24.43 - MISCELLANEOUS STEEL PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that for pipe diameters 24 inches and smaller. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

B. Steel pipe for potable and non-potable water conveyance are covered in the Steel Pipe section.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certification

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All

materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Coated Pipe

1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL PIPE

A. Galvanized steel pipe materials and service shall be as specified herein.

B. Material Classification CSG-1

CSG-1 – Standard Weight Galvanized Steel with Threaded Fittings All pipe sleeves except where plastic sleeves are required.	Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized.
	Fittings	Cast iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.4, Class 125.

C. Material Classification CSG-2

CSG-2 – Standard Weight Galvanized Steel with Threaded Fittings Sump pump discharge piping in interior locations except where buried. Drain piping from equipment.	Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized.
	Fittings	Malleable iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.

D. Material Classification CSG-3

CSG-3 – Standard Weight Galvanized Steel with Flanged Fittings. Sump pump discharge piping in interior locations except where buried.	Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized.
	Fittings	Cast iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.1, Class 125.

E. Accessory Materials

1. Accessory materials for galvanized steel pipe shall be as indicated in the Steel Pipe section of the specification.

2.2 STEEL PIPE

A. Steel pipe materials and service shall be as specified herein.

B. Material Classification CS-2

CS-2 – Standard Weight Steel with Socket Welded Fittings. Natural gas piping, above grade. 2 inch and smaller.	Pipe	ASTM A53/A106, Type S, standard weight, Grade B; plain ends.
	Fittings	Forged steel socket welded. Fittings shall conform to ANSI/ASME B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.

C. Material Classification CS-3

CS-3 – Standard Weight Steel with Buttwelded Fittings. Natural gas piping, above grade. 2-1/2 inch and larger.	Pipe	ASTM A53/A106, Type S, standard weight, Grade B; beveled ends.
	Fittings	Buttwelded. Fittings shall conform to ANSI/ASME B16.9, standard weight.

D. Accessory Materials

1. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples	ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)	Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges	
Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.
Extra Strong Pipe	
Chemical Gas Piping	ASTM A105, forged steel, tongue and groove flanged union type, with nonmetallic gasket; rated for a working pressure of 1,500 psi .
Other services	ANSI/ASME B16.5, Class 300, raised face.
Plastic Lined Pipe	Steel, forged or cast, diameter and drilling in accordance with ANSI/ASME B16.5, Class 150 or 300 as required.
Flange Bolts and Nuts	ASTM A193, Grade B7 with ASTM A194 Grade 2H nuts. Length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.
Flange Gaskets	
[For Process Air Service	
Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, full face, 1/8 inch thick, rated for 275°F service; Garlock "8314".**]**
For Other Services	
Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent

coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ±0.005 inch .

[Mechanical Couplings — Dresser "Style 38" or Smith-Blair "Type 411 Flexible Coupling"; without pipe stop. **]**

Expansion Joints

[Process air — Expansion joints shall be the elastomeric, arched type and shall be Mercer “Type 450” with “Type 500” retaining rings and Kevlar reinforcement, or equal.

The number of arches shall be as indicated on the Drawings. The connection shall be suitable for a maximum pressure of 15 psig and maximum temperature of 250 F . Expansion joints shall have the following ratings:

Number of Arches:	1
Spring rate:	___ lbs/inch
Movement:	___ inch
Number of Arches:	2
Spring rate:	___ lbs/inch
Movement:	___ inch
Number of Arches:	3
Spring rate:	___ lbs/inch
Movement:	___ inch**]**

[Heating water, chilled water, and other services not specified. — FLEXONICS "MODEL H EXPANSION COMPENSATORS" FOR 3 INCH OR SMALLER; FLEXONICS "MID-CORR, SERIES MCB" WITH FLANGED ENDS AND STAINLESS STEEL BELLOWS FOR 4 INCH OR LARGER. EXPANSION JOINTS SHALL BE SUITABLE FOR WORKING PRESSURES UP TO 150 PSIG .**]**

[Material Classification — CS-14: Double wall pipe with leak detection.

Joining — Carrier pipe shall be joined by socket welding. Containment pipe shall be joined by split sleeve of the same diameter as containment pipe with minimum 60 mil thick polyethylene jacket.

End Seal — End seals shall be furnished at all terminal ends. The end seal shall be sealed to the containment pipe.

Leak Detection — Microprocessor based monitoring unit, for continuous monitoring by cable of a single line for water and hydrocarbon.

Control Panel	Modified NEMA Type 12 enclosure, with Status and Alarm Data Model "PAL-AT20C". Power supply to the unit will be 120 volt, 1 phase, 60 Hz. Unit shall be UL listed with alarm horn and shall locate leaks and not depend on battery back-up functions. System conditions shall be stored in memory in the event of power failure and shall automatically resume monitoring without reset once power is available. Monitoring unit shall be able to differentiate between water left in pipe during installation and an actual growing leak. Panel shall also be able to detect a break in sensor cable and its location.
Cable	Cable shall be located in the interstitial space between the carrier and containment pipe, shall detect both water and hydrocarbon, and shall be capable of being dried in place without being replaced after exposure to any fluid Type "AGW-Gold". Coaxial cable shall interface monitoring control panel with sensor cable by utilizing waterproof junction box for protecting connection.**]**

2.3 COATINGS

A. Standard weight steel pipe in buried locations, except hot piping such as aeration air piping, shall have exterior surfaces protected with a shop applied plastic coating. Coatings for hot piping shall be as specified.

B. Extra strong steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating.][shall have exterior surfaces protected with a shop applied tape wrap.][will have exterior surfaces protected with a field applied tape wrap as specified in the Miscellaneous Piping and Accessories Installation section.

C. All surfaces to be tape-wrapped in the shop shall be thoroughly cleaned and primed in accordance with the tape manufacturer’s recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils .

D. Shop applied coatings shall be as follows:

1. External Coatings

   a. Plastic: Liberty Coating Company “Pritec” or Bredero-Shaw “Entec.” The products of other manufacturers will not be acceptable.
   b. Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils ; Protecto Wrap “200” or Tapecoat “CT.”
   c. High temperature epoxy for aeration and process air piping: Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a

minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline “Thermaline 450,” Ameron “Amerlock 400 with Amercoat 880 Additive,” or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 40 05 31.16 - POLYVINYL CHLORIDE (PVC) SEWER PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing polyvinyl chloride (PVC) gravity sewer pipe and fittings, complete with all jointing materials and appurtenances. Ribbed pipe or open profile pipe will not be acceptable.

B. Specifications for alternate pipe materials are covered in other sections.

C. Pipe trenching, bedding, and backfilling are covered in the Trenching and Backfilling section.

1.2 SUBMITTALS

A. General Submittals.

1. Drawings and data shall be submitted in accordance with the Submittals Procedures section. Drawings and data shall include, but shall not be limited to, the items listed in this Section.

B. Details of joints.

C. Gasket material.

D. Pipe length.

E. Certifications

1. Certification in accordance with ASTM D3034, Section 11; ASTM F679, Section 10; ASTM F1803, Section 12.

1.3 DELIVERY, STORAGE AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Pipe, fittings, and accessories shall be handled in accordance with Chapter 6 of AWWA Manual M23, to ensure installation in sound, undamaged condition. Pipe shall not be stored uncovered in direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS

Pipe and Fittings.

Solid wall 4 through 15 inches .	ASTM D3034, Minimum SDR 35, Minimum Cell Classification 12354.
18 through 48 inches .	ASTM F1803, or ASTM F679, Minimum Pipe Stiffness of 46 psi, Minimum Cell Classification 12354.

Jointing Materials.

Bell-and-Spigot Joints.	ASTM D3212, integral bell push-on type elastomeric gasket joints.
Gaskets.	ASTM F477, synthetic rubber. Natural rubber will not be acceptable.
Field-Cut Joints and Connections to Other Piping Materials.	Fernco "Flexible Couplings" or Mission "Eastern Standard Band-Seal Couplings" with stainless steel shear rings.
For Grouted Connections to Cast-in-Place Concrete Manholes	Rubber ring water stop.
Tracer	Detection tape, 3 inches wide; aluminum foil core, 0.5 mil thick, encased in a protective inert plastic jacket; 5,000 psi min tensile strength; 2.5 lbs per inch per 1,000 feet min mass; color coded in accordance with APWA Uniform Color Code; Lineguard "Type III", or Reef Industries "Terra Tape D".

PART 3 - EXECUTION

A. INSTALLATION AND TESTING

1. Pipe shall be installed and tested in accordance with the Sewer Pipe Installation and Testing section.

2. A conductive tracer shall be buried above PVC pipe, not more than 18 inches below the ground surface.

End of Section

SECTION 40 05 32 - MISCELLANEOUS PLASTIC PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous plastic pipe, tubing, and accessories. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certifications.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Pipe, tubing, and fittings shall be stored between 40°F and 90°F .

PART 2 - PRODUCTS

2.1 PVC PIPE MATERIALS

A. PVC pipe materials and services shall be as specified herein.

B. Material Classification PVC-2

PVC-2 – Schedule 80 PVC Pipe with Solvent Welded Joints. Sodium bisulfite solution piping.	Pipe Fittings	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 80. ASTM D2467, Cell Classification 12454, bearing NSF seal. Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

C. Material Classification PVC-4

PVC-4 – PVC DWV Pipe (Single Wall) with Solvent Welded Joints. Chemical resistant waste and vent piping for plumbing systems.	Pipe Fittings	ASTM D1785, cell classification 12454, bearing NSF seal. ASTM D2665 and ASTM D3311, cell classification 12454, bearing NSF seal.

D. Material Classification PVC-5

PVC-5 – PVC DWV Pipe (Double Wall Containment) with Solvent Welded Joints. Chemical resistant waste and vent piping for plumbing systems.	Pipe Fittings	George Fischer Sloane "+GF+Contain-It"; with manufacturer's standard spacers, fittings, and suitable chemical service solvent or equal. ASTM D2665 and ASTM D3311, cell classification 12454, bearing NSF seal.

E. Accessory Materials

1. Accessory materials for the PVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150. Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Stainless steel for DWV and chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2.2 CPVC PIPE

A. CPVC pipe materials and services shall be as specified herein.

B. Material Classification CPVC-1

CPVC-1 – Schedule 80 CPVC Pipe with Solvent Welded Joints. Sodium hypochlorite piping. Sulfuric acid piping post dilution as shown on P&IDs. Potable water and Non-Potable piping. Hot Water, Recirculation water and Tempered water piping **HVAC condensate drain piping**	Pipe Fittings	ASTM F441, Cell Classification 23447, bearing NSF seal, Schedule 80. ASTM F439, Cell Classification 23447, bearing NSF seal. Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

C. Accessory Materials

1. Accessory materials for the CPVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.

Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Stainless steel for chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2.3 PE PIPE

A. PE pipe materials and services shall be as specified herein.

B. Material Classification PE-1

PE-1 – Polyethylene Pipe with Socket Fusion Joints. Natural gas, buried. 2 inch and smaller	Pipe	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. "Yellowstripe 8300".
	Fittings	ASTM D3350, Cell Classification PE 345464C. ASTM D2683, socket type, with wall thickness same as for pipe.

C. Material Classification PE-2

PE-2 – Polyethylene Pipe with Butt Fusion Joints. Natural gas, buried. 3 inch and larger	Pipe	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. "Yellowstripe 8300".
	Fittings	ASTM D3350, Cell Classification PE 345464C. ASTM D3261, butt heat fusion type, with wall thickness same as for pipe.

D. Accessory Materials

1. Accessory materials for the PE Pipe systems shall be as indicated.

Flanges	Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch beyond outer face of the

	nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern.
Fittings and Flange Adapters	Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

2.4 POLYPROPYLENE PIPE

A. Polypropylene pipe materials and services shall be as specified herein.

2.5 REINFORCED PLASTIC TUBING

A. Reinforced plastic tubing materials and services shall be as specified herein.

B. Material Classification RPT-1

RPT-1 – Reinforced Plastic Tubing. Flexible connections in chemical piping 1/2 inch and smaller.	Tubing	Wire reinforced PVC hose; Cobon Plastics Corp. "Cobovin Type S" or NewAge Industries Inc. "Vardex".

2.6 TEFLON (PFA) HOSE

A. PFA hose materials and services shall be as specified herein.

B. Material Classification TEFL-1

TEFL-1 – Teflon Hose. Flexible hose for chemical diffusers.	Hose	Polypropylene braided, convoluted PFA Teflon Hose; PureFlex Inc “ProFlex”, or preapproved equal.
	Fittings	Connections shall be accomplished using ProFlex Style 11 or equal fittings constructed of solid Kynar and installed at the factory. Splices and hose fittings shall be factory installed. Tubing connections to hard pipe shall be flange type or as recommended by the tubing manufacturer with wetted parts suitable for the chemical. Where barbed fittings are required the clamps shall be of stainless steel with blow-off proof crimping collar.

	Field connections shall be accomplished using ProFlex Style 03 or equal fittings constructed of solid Kynar.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 40 05 41 - MISCELLANEOUS PIPING AND PIPE ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous piping and pipe accessories. Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittal Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certifications

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Miscellaneous piping materials shall be as specified herein.

B. Material Classification BR-1

BR-1 – Regular Weight Brass Pipe Gauge piping for hot/cold water. Gauge piping for seal water. Gauge piping for compressed air.	Pipe Fittings	ASTM B43, red brass, seamless, regular weight. ANSI/ASME B16.15, Class 125.

C. Material Classification HS-1

HS-1 – Hose with Flanged Connections Flexible connections in chemical piping, specifically to HDPE tank nozzles or other such flanged connections not suitable to be hard piped.	Hose Connections	ID not smaller than nominal size. Boston " Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical. Pre-fit hose of a certain length with manufactured flanged ends and factory assembled. Manufactured flanged ends constructed of rigid PVC or other material suitable for service conditions, with band type stainless steel clamps. Hose barbs or threaded connections not permitted.

D. Material Classification HS-2

HS-2 – Hose with Quick Disconnect Couplings Flexible connections in chemical piping, specifically to totes and other such temporary appurtenances.	Hose Couplings	ID not smaller than nominal size. Boston "Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical. To be fully factory assembled including connection fittings. Cam-lock type quick connect/disconnect couplers and adapters as manufactured by OPW or PT. Coupling shall be fastened via band type stainless steel clamps. Hose barbs or threaded connections not permitted.

E. Material Classification CRP-1

CRP-1 – Carpenter 20-Cb3 Pipe with Socket Weld Fittings Sulfuric acid piping, except where indicated otherwise.	Welded Seamless Fittings	ASTM B464 - UNS NO8020, schedule 40. ASTM B729 - UNS NO8020, schedule 40. Socket weld, Class 3000, ASTM B462 - UNS NO8020. The use of flanged fittings shall be limited to equipment connections.

F. Accessories

1. Accessories for the miscellaneous piping systems shall be as indicated.

a. Unions for brass pipe Fed Spec A-A-59617, Class 125.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 40 05 51.13 - VALVE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of new valves and actuators purchased by Contractor as part of this Work.

B. Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

C. The following specification sections are applicable to valves to be installed:

	Title
1.	Angle Valves
2.	Miscellaneous Ball Valves
3.	Check Valves
4.	Backflow Preventers
5.	Solenoid Valves
6.	Globe Valves
7.	Pinch and Diaphragm Valves
8.	Pressure Reducing Valves
9.	Miscellaneous Valves
10.	Basin Valves
11.	AWWA Butterfly Valves
12.	Resilient-Seated Gate Valves
13.	Air Valves

1.2 GENERAL

A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Coordination

1. Flanged, push-on, and grooved connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section. Valve ends shall match piping.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSPECTION

A. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 INSTALLATION

A. General

1. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

2. Unless otherwise indicated on the Drawings or specified, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.

B. AWWA Butterfly Valves

1. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.

2. Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.

C. Check Valves

1. Lift Check Valves

a. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

2. Swing Check Valves

a. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

3. Low Pressure Air Service Check Valves

a. Dual disc wafer check valves installed in the discharge piping of centrifugal blowers shall be positioned with the valve hinge perpendicular to the impeller shaft of the blower.

D. Resilient Seated Gate Valves

1. Resilient Seated Gate Valves

a. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendices to ANSI/AWWA C509 and C515 and with the recommendations of the manufacturer.

2. Double Disc Gate Valves

a. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to ANSI/AWWA C500 and with the recommendations of the manufacturer.

E. Air Release and Combination Air Valves

1. The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches above the floor.

F. Hydrants

1. Fire Hydrants

a. Fire hydrants shall be set so that at least the minimum pipe cover is provided for the branch supply line and the nozzles are at least 12 inches above finished grade. Each hydrant shall be set on a concrete foundation at least 18 inches square and 6 inches thick. Each hydrant shall be blocked against the end of the trench with concrete or shall be suitably anchored.

b. Hydrant drainage shall be provided by installing at least 7 cubic feet of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.

c. All hydrants shall stand plumb. Hydrants with pumper nozzles shall have hose nozzles parallel with, and the pumper nozzle perpendicular to, the curb line. Hydrants having hose nozzles 90 degrees apart shall be set so that the line bisecting the angle between the nozzles is perpendicular to the curb line. Hydrants located behind curbs, where sidewalks extend close to or abut the curb, shall be set so that no portion of the pumper or hose nozzle caps will be less than 6 inches or more than 12 inches from the gutter face of the curb. Where set between the curb and sidewalk, or between the sidewalk and property line, no portion of the hydrant or nozzle cap shall be within 6 inches of the sidewalk.

d. Immediately before installation of a fire hydrant, the following procedure shall be followed: (a) the hydrant shall be thoroughly inspected; (b) the hydrant interior shall be thoroughly cleaned; and (c) the hydrant shall be opened and closed as many times as may be necessary to determine if all parts are in proper working order, with valves seating properly and the drain valve operating freely.

G. Valve Boxes

1. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3.3 VALVE ACTUATORS

A. Valve actuators and accessories shall be factory mounted on the valve, calibrated, and tested by the valve or actuator manufacturer.

3.4 FIELD QUALITY CONTROL

A. Field Testing

1. After installation, all valves shall be tested in accordance with the Pipeline Pressure and Leakage Testing section.

2. Pressure Tests

a. Pressure testing shall be in accordance with the Pipeline Pressure and Leakage Testing section.

3. Leakage Tests

a. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor. This requirement applies whether pressure testing is required or not.

3.5 ADJUSTING

A. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

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SECTION 40 05 51.16 - GATE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of new gates and actuators purchased by Contractor as part of this Work.

B. The following specification sections are applicable to gates to be installed under this contract:

1. Open-Channel Metal Slide Gates and Weir Gates

1.2 GENERAL

A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Any gates and actuators identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

C. Coordination

1. When installation check services are provided by the gate manufacturer, Contractor shall coordinate the services with the gate manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's installation check services.

2. Submittals for equipment furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be as follows:

1. Grout As specified in the Grouting section.

PART 3 - EXECUTION

3.1 INSPECTION

A. All gates and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 INSTALLATION.

A. General

1. Gates and appurtenances shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the gate for maintenance. Installation shall be in accordance with the manufacturer's recommendations and the requirements specified herein.

2. All bolts shall be tightened and all items requiring lubrication, including pivot pins, shall be lubricated. Anti-seize thread lubricant shall be liberally applied to the threaded portion of stainless steel anchor bolts during the installation and tightening of nuts. Excess lubricant shall be thoroughly removed following final tightening.

3. The threaded portion of each plastic stem cover shall be wrapped in at least two layers of teflon thread tape, and the threaded portion of steel pipe stem covers shall be coated with teflon thread sealer immediately prior to installation of the cover on the actuator.

4. Each gate shall be adjusted so that it does not bind or leak in excess of specified requirements. After installation, each gate shall be operated through at least two complete open-close cycles, re-adjusted and re-operated as necessary, and left in a condition acceptable to Engineer.

B. Installation Checks

1. When specified in the gate sections, the gate manufacturer will provide installation checks. For installation checks, the manufacturer’s field representative will inspect the gate installation immediately following installation by Contractor. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

2. Contractor shall perform no Work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

C. Open-Channel Metal Slide Gates and Weir Gates

1. Each open-channel slide gate or weir gate shall be carefully installed and adjusted for proper operation. Care shall be taken to avoid deformation of the gate frames and to maintain tolerances between seating faces.

2. Each embedded frame shall be carefully braced in the forms before concrete is placed, or a space shall be boxed out and the frame shall be grouted in place later. Care shall be exercised to ensure that frame members and anchor bolts do not rest upon or contact steel reinforcing bars.

3. Components of aluminum open-channel slide gates or weir gates installed in contact with concrete, shall be coated with epoxy in accordance with the Protective Coatings section prior to installation. Damaged areas of shop-applied coatings shall be re-coated and allowed to cure before placement of concrete or grout. Anchor bolts shall be carefully set using a template.

3.3 GATE ACTUATORS

A. Gate actuators and accessories shall be installed in accordance with the equipment manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. Field Testing

1. After installation, all gates shall be pressure tested for leakage at the hydrostatic heads specified. Leakage exceeding the specified limits which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

B. Cast-Iron Slide Gates

1. For the maximum seating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter. For the maximum unseating heads, the leakage shall not exceed 0.2 gpm per foot of the seating perimeter.

C. Fabricated Stainless Steel Slide Gates

1. For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

D. Open-Channel Metal Slide Gates

1. For the maximum seating and unseating heads, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.

3.5 ADJUSTING

A. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic, or electric actuated gate.

End of Section

SECTION 40 05 56 - MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous valves as specified herein and as indicated in the, except where specific requirements are stipulated in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within ±1/16 inch of the specified or theoretical length.

B. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy (for liquid service)	PPG Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Sherwin-Williams "Macropoxy 646NSF"or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves to be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy or Epoxy.
Exterior Surfaces of all Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 HOSE FAUCETS, HYDRANTS, AND CURB STOPS.

A. Hose Faucets, VHF-1

VHF-1 Hose faucet	Type	Faucet, threaded bonnet.
	Body/Bonnet	Brass.
	Trim	
	Seat	Manufacturer's standard.
	Disc	Manufacturer's standard.

	Stem	Manufacturer’s standard.
	Stem Seal	Manufacturer’s standard.
	End Connection	Threaded, male NPT x male HPT.
	Temp. Limitations	32°F to 212°F .
	Valve Operator	T-handle.
	Manufacturers	Prier Brass "C - 138NP.75" or equal.

B. Wall Hydrants, VHF-2

VHF-2	Type	Freezeproof.
Wall	Body/Bonnet	Brass or bronze.
hydrant	Trim	
	Seat	Manufacturer’s standard.
	Disc	Manufacturer’s standard.
	Stem	Manufacturer’s standard.
	Stem Seal	Manufacturer’s standard.
	End Connection	Threaded, NPT x male HPT.
	Temp. Limitations	32°F to 212°F .
	Valve Operator	Removable key.
	Manufacturers	Smith "5609", Wade " 8600", Woodford "65" or “67”, or Zurn "Z-1315".

C. Wall Hydrants with Vacuum Breaker, VHF-3

VHF-3	Type	Freezeproof, with vacuum breaker.
Wall hydrants with vacuum breaker	Body	Brass or bronze.
	Trim	
	Seat	Manufacturer’s standard.
	Disc	Manufacturer’s standard.
	Stem	Manufacturer’s standard.
	Stem Seal	Manufacturer’s standard.
	End Connection	Threaded, NPT x male HPT.
	Temp. Limitations	32°F to 212°F .
	Valve Operator	Removable key.
	Manufacturers	Smith "5609", or Wade " 8600".

D. Post Type Yard Hydrants, VHF-5

VHF-5 Post type yard hydrant	Type	Nonfreeze, post type.
	Body	Brass or bronze.
	Trim	Manufacturer’s standard.
	Seat	Manufacturer’s standard.
	Disc	Manufacturer’s standard.
	Stem	Manufacturer’s standard.
	Stem Seal	Threaded, NPT x HPT.
	End Connection	32°F to 212°F .
	Temp. Limitations	Removable key.
	Valve Operator	Smith "5910/5914", Wade "8610", or Zurn "Z-1385/1390".
	Manufacturers	

E. Curb Stops, VCS-1

VCS-1 Curb stop	Code	ANSI/AWWA C800.
	Type	Straight-through.
	Body	Brass or bronze.
	Trim	Manufacturer's standard.
	Seat	Manufacturer's standard.
	Plug/Ball	Manufacturer's standard.
	Stem	Manufacturer's standard.
	Stem Seal	Threaded.
	End Connection	32°F to 212°F .
	Temp. Limitations	T-handle.
	Valve Operator	Ford Meter Box "Ford Ball Valve", Hays "Nuseal Curb Stop", or Mueller "Mark II Oriseal".
	Manufacturers	

F. Fire Hydrants

1. Fire hydrants will be furnished by the Owner and shall be installed by the Contractor.

2. Fire hydrants shall conform to ANSI/AWWA C502. The information required by Paragraph III. A. of the ANSI/AWWA C502 foreword shall be as indicated below.

Affidavit of compliance Not required.

Catalog and maintenance data	Required.
Type of shutoff	Compression or gate.
Size of hydrant (valve opening)	4-1/2 inches or 5-1/4 inches .
Inlet connection	6 inch , locked push-on.
Harnessing lugs	Not required.
Depth of bury	As indicated on the Drawings.
Outlet nozzles	Two 2-1/2 inch hose nozzles and one 4 inch pumper nozzle.
Outlet nozzle threads	See Note 1.
Direction to open	Counterclockwise.
Stem seals	O-ring.
Outlet nozzle cap chains	Required.
Drain outlet	Required.
Operating nut	See Note 2.
Outlet nozzle cap nut	See Note 2.

Notes

1. Outlet nozzle threads shall be the Owner's standard thread.

2. The operating nut and outlet nozzle cap nut shall be of the Owner's standard shape and size.

2.3 BASIN VALVES

A. Mud Valves

1. Mud valves shall be flanged or spigot end, nonrising or rising stem type as indicated on the Drawings, with threaded stem, seat ring, and gate ring of bronze. Each valve shall be provided with coupling nut, extension stem, stem guides, and operating stand, wheel, or wrench nut, as indicated on the Drawings. Mud valves shall be installed with the valve seat level.

2.4 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuator section.

2.5 ACCESSORIES

A. When the Drawings indicate the need for extension stems; position indicator; floor boxes; or operating stands, refer to the Valve and Gate Actuator section.

B. Valve Boxes

1. Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch thick, and shall be provided with suitable cast iron bases and covers.

2. Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and base, and a 6 inch cast iron pipe section. The cover and base shall be Clay & Bailey "No. 2193NS". The pipe shaft shall extend from the valve to 5 inches inside the valve box base. Valve boxes constructed from composite materials in lieu of the cast iron pipe type in non traffic areas

3. All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer’s standard coating.

4. Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

B. Installation Check

1. An installation check by an authorized representative of the manufacturer is not required.

End of Section

SECTION 40 05 57 - VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing manual and powered valve and gate actuators and accessories as specified herein.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, cylinder and vane type actuators shall conform to applicable requirements of ANSI/AWWA C541.

2. Except as modified or supplemented herein, electric motor actuators shall conform to applicable requirements of ANSI/AWWA C542.

3. Except as modified or supplemented herein, actuators for butterfly and eccentric plug valves shall conform to the applicable requirements of ANSI/AWWA C504.

4. Except as modified or supplemented herein, manual actuators for ball valves shall conform to the applicable requirements of ANSI/AWWA C507.

5. Except as modified or supplemented herein, actuators for cast-iron slide gates shall conform to the applicable requirements of ANSI/AWWA C560.

6. Except as modified or supplemented herein, actuators for stainless steel slide gates shall conform to the applicable requirements of ANSI/AWWA C561.

7. Except as modified or supplemented herein, actuators for composite slide gates shall conform to the applicable requirements of ANSI/AWWA C563.

E. Power Supply

1. Power supply to electric actuators will be as indicated in the valve and gate schedules.

F. Marking

1. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

G. Temporary Number Plates

1. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

1.3 SUBMITTALS

A. Drawings and Data General

1. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

B. Drawings and Data – Electrical and Wiring Diagrams

1. Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

C. Network Valve Actuator Data.

1. For networked valve actuators, information on the available input and output assemblies shall be submitted for the protocol(s) specified to be provided. The submittal shall identify the version of the selected network protocol for which the device has been tested and certified.

D. Testing Certifications and Results.

1. For electric or cylinder actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, together with an affidavit of compliance as indicated in Section 6.3 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, shall be submitted to Engineer before the actuators are shipped.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. General

1. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve and gate sections.

2. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

B. Valve Actuators

1. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve schedules.

2. Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Engineer.

3. When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet .

C. Gate Actuators

1. Actuators shall be sized to produce the torque or thrust required to operate the gate when subject to the seating and unseating operating heads as indicated in the respective gate schedules.

2. Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

D. Limit Switches

1. Limit switches shall be provided as indicated on the Drawings or in the valve and gate schedules.

2. For manual or cylinder type actuators, each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

3. Limit switches for intelligent and standard electric actuators shall be as indicated in their respective paragraphs.

2.2 MATERIALS

A. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable governing standard(s).

2.3 VALVE MANUAL ACTUATORS

A. General

1. Manual actuators of the types listed in the valve specifications or schedules shall be provided by the valve manufacturer.

2. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

3. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.

B. Handwheels

1. Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.

C. Chainwheels.

1. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized or zinc plated carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.

D. Levers

1. Levers shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

E. Chain Levers

1. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.

F. Wrench Nuts

1. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

G. Operating Stands

1. Operating stands shall be provided in the locations indicated on the Drawings or as indicated in the valve and gate schedules. Operating stands shall support the handwheel approximately 36 inches above the floor. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem.

H. Wall Brackets

1. Wall brackets shall be provided to support manual actuators in the locations indicated on the Drawings or in the respective valve schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.4 GATE MANUAL ACTUATORS

A. General

1. Manual actuators of the types listed in the gate schedules shall be provided by the gate manufacturer. Unless otherwise specified, actuators shall conform to ANSI/AWWA C560.

2. All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.

3. The direction of rotation of the wheel, crank, or wrench nut to open the gate shall be to the left (counterclockwise).

4. Actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.

5. When indicated in the gate schedules, crank-operated actuators shall be suitable for operation with a portable actuator specified herein. A suitable adapter coupling shall be furnished with each crank actuator to couple the portable actuator to the crank actuator pinion shaft as required.

B. Stem Covers

1. Rising stem manual actuators shall be provided with a stem cover as indicated in the gate schedules. Stem covers shall conform to Section 4.4 of ANSI/AWWA C560.

2. Plastic Covers

a. Covers shall be constructed of transparent plastic pipe and shall be furnished with an end cap, condensation vents, and a clear mylar position-indicating marking tape. The marking tape shall be adhesive backed and shall be permanently marked and calibrated in feet and inches . The tape shall be applied to the stem cover after the gate has been installed and shall be so positioned that the height of the slide will be indicated by reference to the top of the stem.

3. Steel Covers

a. Covers shall be constructed from steel pipe and shall be furnished complete with a threaded end cap. All steel components of each cover shall be hot-dip galvanized following fabrication.

b. The operating mechanism shall be furnished with a digital or dial type mechanical position indicator. The indicator mechanism shall be installed inside a weatherproof housing and shall be clearly visible through a transparent, weatherproof window.

2.5 INTELLIGENT ELECTRIC ACTUATORS

A. General

1. Intelligent electric actuators as listed in the valve and gate schedules shall be provided by the valve or gate manufacturer.

2. Intelligent electric actuators with torque output requirements of 750 ft-lbs and less for butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "AUMATIC SQBV 05.1 through SQBV 12.1", EIM “HQ Series”, Limitorque "QX" or Rotork “IQT Series” without exception.

3. All other intelligent electric actuators for open-close service shall be multi-turn type and shall be Auma “AUMATIC AC SABV 07.2 through SABV 16.2”, EIM “TEC2/TEC2000”, Limitorque "MX", or Rotork "IQ Series", without exception.

4. Intelligent electric actuators for modulating service shall be Auma “AUMATIC AC SARBV 07.2 through SARBV 16.2”, EIM “TEC2/TEC2000”, Limitorque “MX”, or Rotork “IQ Series”, without exception.

5. Intelligent electric actuators for explosion proof service shall be Auma “AUMATIC AC SAExBV/SARExBV 07.2 through SAExBV/SARExBV 16.2”, EIM “TEC2/TEC2000”, Limitorque “MX”, or Rotork “IQ Series” without exception.

6. Intelligent electric actuators produced by other manufacturers are not acceptable.

7. Intelligent electric actuators shall be capable of non-intrusive configuration without requiring removal of any actuator covers. Configuration of actuator functions shall be by use of a handheld infrared linked device, laptop or PDA with compatible wireless communication capability, or by local control switches and 32-character LCD display mounted on the actuator housing. The display language shall be English .

8. Each intelligent electric actuator shall be furnished complete with a motor, gearing, handwheel, configurable output relays, torque sensors, lubricants, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a ductile iron or aluminum alloy housing, of a type as indicated in the valve and gate schedules and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer. Housings shall have two O-ring seals, one on the controls compartment and one on the terminal cover.

9. Actuators shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as indicated in the valve and gate schedules.

10. Actuator motors may be mounted horizontally adjacent to or vertically above the reduction gearing. All gearing shall be oil or grease lubricated.

B. Motors

1. Motors shall be totally enclosed, high torque design made expressly for valve and gate actuator service, capable of operating the valve or gate under full differential pressure for two complete strokes or one complete cycle of travel without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated. Motors shall be provided with stall, temperature, loss of phase, and reverse phase protection. Actuators shall be capable of indicating phase loss. Motors for open-close service shall be rated for a minimum of 60 starts per hour and motors for modulating service shall be rated for a minimum of 1,200 starts per hour.

C. Power Gearing

1. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing, aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch or electronic torque protection device by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gearbox is required, it shall be designed to withstand the locked rotor torque of the actuator.

D. Handwheel Mechanism

1. The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. The handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 lbs . The handwheel shall have a padlockable declutch lever.

E. Torque Sensing

1. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Torque settings shall be adjustable and shall be indicated locally. The adjustment shall permit a variation of 40 to 100 percent of rated torque.

F. Terminal Facilities

1. Terminal facilities for connection to motor leads, switches, and control and indication signals shall be provided in a readily accessible terminal compartment. The terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch and the other at least 1-1/4 inches . Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG conductors.

G. Controls Compartment

1. Each actuator shall be furnished with a sealed compartment containing a reversing controller, multi tap transformer, electronic controls, and monitoring and protection modules. Reversing controllers shall be both mechanically and electrically interlocked and provided with the necessary direct-operated auxiliary contacts for required interlocking and control. The multi tap transformer shall provide power for all internal circuits, and shall provide 120 VAC supply for remote controls as indicated in the valve and gate schedules, or in the schematics on the Drawings.

2. Where not networked, actuators for valves or gates listed for modulating service in the valve and gate schedules shall be provided with a control module for position modulating type service. The control module shall be mounted within the controls compartment. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband. Non-networked modulating actuators shall have a 4 to 20 mA output signal proportional to valve or gate position.

H. Local Controls

1. Each actuator shall have controller devices mounted on the actuator as indicated in the valve and gate schedules.

I. Remote Indication and Controls

1. Valve or gate position and actuator status indication for non-networked valves shall be provided by four configurable output relay contacts which can be selected to indicate any position of the valve or gate. Relays shall be configurable to the normally open or normally closed states. Relays shall maintain and update position indication during handwheel operation. Contacts shall be rated 5 A, 250 VAC, 30 VDC. When not used for position indication, any of the four configurable relays shall be selectable to signal one of the following:

    a. Valve or gate opening, closing, or moving.
    b. Thermostat tripped, phase loss.
    c. Motor tripped on torque in mid travel, motor stalled.
    d. Remote mode selected.
    e. Local mode selected.

2. At a minimum, the actuator shall transmit the following status information through network:

    a. Valve opening, closing, or moving.
    b. Valve full open, full closed.
    c. Thermostat tripped, phase loss.
    d. Motor tripped on torque in mid travel, motor stalled.
    e. Remote mode selected.
    f. Local mode selected.
    g. Valve position.
    h. Valve torque.

2.6 ACTUATOR ACCESSORIES

A. Extension Stems

1. Extension stems and stem guides shall be furnished when indicated in the respective valve schedules, indicated on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

2. At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet , whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

3. Extension stems for chemical resistant butterfly valves located in drainage sumps shall be the two-piece type with stainless steel stem, PVC housing, wall support, and collar. Unless otherwise indicated on the Drawings, the length of the stem extension shall be as necessary to position the valve operator 12 inches above the maximum liquid level in the immediate area.

4. Extension stems for buried valve actuators shall extend to within 6 inches of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

5. Extension stems for buried valve actuators shall be provided with position indicators as specified in the valve schedules.

B. Position Indicators

1. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.

2. For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.

3. Each actuator for butterfly valves, except where located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

C. Floor Boxes

1. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the Drawings. Where the operating nut is in the slab, the stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

2. Each floor box and cover shall be shop coated with manufacturer's standard coating.

D. Torque Tubes

1. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the valve floorstand operator. An adjustment of 2 inches [50 mm] shall be provided in the torque tube installation. Torque tube shall be coated with the same material as the submerged valve.

E. Valve Boxes

1. Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch [4.7 mm] thick, and shall be provided with suitable cast iron bases and covers.

2. Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and a 6 inch Cast Iron Pipe section. The cover shall be Clay & Bailey "No. 2193". The pipe shaft shall extend from the valve to 5 inches inside the valve box cover.

3. All parts of valve boxes, bases, and covers shall be shop coated with manufacturer's standard coating.

4. Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 SHOP PAINTING

A. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

B. The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Actuators will be installed on the valves in accordance with the Valve Installation section and on gates in accordance with the Gate Installation section.

End of Section

SECTION 40 0559.13 - OPEN-CHANNEL METAL SLIDE GATES AND WEIR GATES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing slide gates and actuators as specified herein and as indicated in the Open Channel Metal Slide Gate and Weir Gate Schedule. Slide gates shall be furnished complete with frames, slides, seals, actuators, operating stems, and appurtenances as specified herein, as indicated in the schedule and as specified in the Valve and Gate Actuator section.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Gates and actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest products of a manufacturer engaged in the production of slide gates.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all slide gates shall conform to the applicable requirements of ANSI/AWWA C561 and ANSI/AWWA C562.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Complete drawings, construction details, anchorages, and specifications covering the slide gates and appurtenances shall be submitted in accordance with the Submittals Procedures section. Each drawing shall be identified with the slide gate designation.

B. Electrical and Wiring Drawings

1. Drawings shall include separate wiring diagrams for each electrically actuated gate and related electrical control equipment.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Slide gate used to regulate the polishing pond effluent.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Slide gates shall be designed for the conditions and requirements indicated in the Slide Gate Schedule.

B. Design

1. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fourth of the ultimate strength of each material.

2. Gates shall be designed for the seating and unseating heads indicated in the Slide Gate Schedule.

3. Gates shall be designed to fit into the structures indicated on the Drawings.

2.3 ACCEPTABLE MANUFACTURERS

A. For slide gates acceptable manufacturers are Coldwell-Wilcox, Golden Harvest, Hydro Gate, Waterman, Fontaine, Rodney Hunt, and Whipps.

2.4 MATERIALS

Frames, Guides, Slides, Reinforcing Members, and Yoke Beams	Stainless steel, ASTM A276, 304L or 316L and ASTM A240, 304L or 316L.
Flush Bottom Closure Seal	Compressible neoprene.
Hollow Bulb J-Seals	Compressible neoprene.
Seal Retainer Bar	Aluminum, ASTM B211 or B221, Alloy 6061-T6.
Slide Seats and Bearing Bars	UHMW polyethylene.
Operating Stems	Stainless steel, AISI Type 304 or 316.
Assembly Fasteners	Stainless steel, AISI Type 302, 303, or 304.

Epoxy Enamel	PPG-Amercoat "Amercoat 385 Epoxy", Carboline "Carboguard 890", Sherwin-Williams "Macropoxy 646" or Tnemec "Series N69 Hi-Build Epoxoline II".
Epoxy Enamel (NSF Certified Systems)	PPG-Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Sherwin-Williams "Macropoxy 646NSF" or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Anchor Bolts	As indicated in the Anchorage in Concrete and Masonry Section.

2.5 CONSTRUCTION

A. Frames

1. Each frame shall be an integral unit of extruded or welded structural shapes at least 1/4 inch thick. Frames shall be designed for embedment in concrete or installation on the face of concrete walls as indicated in the Slide Gate Schedule. Embedded frames shall be recessed so that the waterway is not obstructed.

2. Guides shall be provided on each side of each frame. Guides shall be sufficiently strong to require no further reinforcing where they extend above the operating floor, and shall support the entire height of the slide in all positions.

3. Full-length plastic slide seats or bearing bars shall be provided on the downstream side of the slide on gates subject to seating pressure from one direction. Gates subject to seating pressure from either direction shall be provided with plastic seats or bearing bars on both faces of the slide. Seats and bars shall be mechanically retained in the frame.

4. Self-contained gates shall be equipped with a yoke, shop welded to the top of vertical frame members to support the actuator. Yokes shall be fabricated from a pair of rolled or extruded channels or angles and shall be designed to deflect not more than 1/360 of the span when the gate is operated at the maximum actuator thrust with the safety factor as indicated in the governing standard. Each yoke shall be designed to permit vertical removal of the slide. Actuators shall be mounted so that no eccentric loads are transmitted to the yoke.

B. Slides

1. Slides shall be at least 1/4 inch thick and shall be provided with welded stiffeners to limit deflection to 1/360 under the maximum seating or unseating head indicated in the Slide Gate Schedule. Slides shall be adequately reinforced to withstand, without permanent distortion, the maximum thrust which can be transmitted by the operating stem. Each slide shall have a reinforced pocket or an internally threaded nut welded to the slide for

connection of the stem. The pocket or nut shall be designed to withstand the maximum thrust which can be transmitted by the operating stem.

C. Closures

1. The bottom of each slide gate frame shall be recessed so that the waterway is not obstructed. A compressible seal shall be securely attached to the bottom of the slide or to the frame invert. The seal shall be of sufficient length to seal the bottom corners of each slide.

2. Where indicated in the Slide Gate Schedule, gates shall be provided with resilient hollow bulb J-seals attached to the frame members.

3. For weir service, slides may be lowered below the bottom of the opening. A frame member shall be provided at the bottom of the opening to seal the space between the slide and the adjacent concrete. The side guides shall be extended below the bottom of the wall opening. A resilient hollow bulb J-seal shall be attached to the frame along the invert of the opening and up both sides to seal the slide in any positions.

4. Each J-seal shall be provided with a full-length retainer bar which shall compress the seal and prevent leakage between the seal and the frame member. The method of attachment of J-seals to frame members shall permit replacement of the seals without disassembling or removing the gate.

5. An acceptable alternative to J-seal is a UHMW polyethylene seal/seat. A UHMW polyurethane seat/seal extruded shape shall fit into a dovetail grove in the guide section, and shall seal on both upstream and downstream sides of the slide. The seat/seal system shall act as both a bearing surface and as a seal, and the seal system shall be self-adjusting. The seat/seals shall be easily replaced without removing the gate from the wall. For flush bottom application, the invert shall have a replaceable resilient neoprene seal mounted on the frame invert.

D. Operating Stems

1. Operating stems shall conform to the requirements of Section 4.3.6 of the governing standard. Contact surfaces of threads shall be rolled or machined to a 63 microinch finish, or smoother. Each stem shall be securely attached to the slide.

E. Stainless Steel

1. All stainless steel shall be pickled in accordance with ASTM A380 at the mill before being shipped. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall be repickled or passivated in accordance with ASTM A380 as needed to remove all traces of iron contamination. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces.

2.6 ACTUATORS

A. Actuators and their accessories shall be the type as indicated in the Slide Gate Schedule and as specified in the Valve and Gate Actuator section.

B. Stem covers for manual actuators shall be UV resistant clear plastic, polycarbonate, or steel pipe as indicated in the Slide Gate Schedule and as specified in the Valve and Gate Actuator section.

C. The gate manufacturer shall furnish portable electric actuators as specified in the Valve and Gate Actuator section.

2.7 SHOP PAINTING

A. All surfaces of aluminum which will be in contact with concrete, mortar, grout, or dissimilar metals shall be given a coat of epoxy enamel or coal tar epoxy. The epoxy coating shall be NSF certified for gates installed in a potable water facility.

2.8 SHOP TESTING

A. Gates shall be completely assembled in the shop to ensure that all parts fit together properly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Slide gates and appurtenances shall be installed in accordance with the Gate Installation section.

B. Installation Check

1. An installation check by an authorize representative of the manufacturer is not required.

2. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

3. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

4. All costs for these services shall be included in the contract price.

End of Section

Schedule 15114-S02
Open Channel Slide Gates Schedule
Electric Actuators

Tag Number	Location(1)	Type of Service(2)	Nominal Size WxH	Maximum Head of Water(seating) Above Invert Gate	Maximum Head of Water(unseating) Above Invert Gate	Invert Elevation	Operating Floor Elevation	Top of Yoke Elevation	Type of Mounting(3)	Type of Closure(4)	Dual Stems Required	Special Notations(6)	Suitable for Use with an Electric Portable Actuator	Suitable for Use with a Hydraulic Portable Actuator	Type of Electric Actuator (5)	Type of Housing(9)	Operating Time	Power for Electric Actuator Motor	Actuator Provides 120VAC for Remote Controls	Number of Limit Switch Assemblies	Position Transmitter	Control Devices (10)
			(in)	(ft)*	(ft)*	(ft)	(ft)	(ft)									(s)	(V/PH)				
TE-G-3001	JS	M	72X48.5	4	4	626	630.5	633+/-	ESC	WS	No		No	No	IE	WP		460/3	Yes		Yes	C

Schedule 15114-S02
Open Channel Slide Gates Schedule

Notes:

(1) Abbreviations for locations are as indicated:

JS	Juntion Structure

(2) Abbreviations for services are as indicated:

O-C	Open - Close
M	Modulating

(3) Abbreviations for types of mountings are as indicated:

ESC	Embedded, self-contained
ENSC	Embedded, non-self-contained
FSC	Face (wall) mounted, self-contained
FNSC	Face (wall) mounted, non-self-contained

(4) Abbreviations for types of closures are as indicated:

FB	Flush bottom
FBJS	Flush bottom with hollow bulb J-seals
WS	Weir service, downward opening, with hollow bulb J-seals

(5) Abbreviations for types of electric actuators are as indicated:

IE	Intelligent Electric
IEFS	Intelligent Electric with concentric floor stand
SE	Standard Electric
SEFS	Standard Electric with concentric floor stand
D-	Prefix where dual actuators are required
-WB	Suffix where wall brackets are required

(6) Special notations and requirements are as indicated:

A Design considerations restrict the maximum travel of this gate to less than gate height; at maximum design flow, the lower portion of the gate slide may extend below the water surface when the gate is open.
B Interconnected dual actuators and dual stems are required.
C This gate may be subject to the specified seating pressure applied from either direction.
D The gate shall be provided with a rectangular port in the slide for flow regulation and shall be designed so that the slide can be raised or lowered from the indicated position.

(7) Abbreviations for types of manual actuators are as indicated:

CGBS Crank-operated, geared, benchstand
CGFS Crank-operated, geared, concentric floorstand
CGOFS Crank-operated, geared, offset floorstand
HBS Handwheel-operated, non-geared, benchstand
HFS Handwheel-operated, non-geared, concentric floorstand
HGBS Handwheel-operated, geared, benchstand
HOFS Handwheel-operated, non-geared, offset floorstand
RA Remote actuator, benchstand with side handwheel and chain drive

(8) Abbreviations for limit switches on manual operated gates.

EOT End of travel (open - close)
PSS Pump start - stop (two intermediate positions)
ELSCH See electrical schematics

(9) Abbreviations for electronic or electric actuator housing.

WP Weatherproof
SUB Submersible [xx = depth of submergence](SUBxx)
EXP Explosion proof

(10) Abbreviations for control devices are as indicated.

Table 1: Control Devices

Abbreviations	Open-Close Push Button	Open-Stop-Close Push Button	Local-Off-Remote	Red and Green Indicator Lights
A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

END OF SCHEDULE

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SECTION 40 05 61.23 - RESILIENT-SEATED GATE VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing resilient-seated AWWA gate valves for clear water service and as indicated in the Resilient-Seated Gate Valve Schedule. Resilient-seated gate valves shall be furnished complete with actuators and accessories as specified herein and as specified in the Valve and Gate Actuator section.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all resilient-seated gate valves shall conform to the applicable requirements of ANSI/AWWA C509 or ANSI/AWWA C515.

E. Temporary Number Plates

1. Each resilient-seat gate valve shall be tagged or marked in the factory with the identifying number listed in the Resilient-Seated Gate Valve Schedule.

F. Identification

1. Resilient seated gate valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Except as modified or supplemented herein, materials used in the manufacture of resilient-seated gate valves shall conform to the requirements of the governing standard.

B. Bronze Components

1. All bronze valve components in contact with liquid shall contain less than 16 percent zinc. All aluminum bronze components in contact with liquid shall be inhibited against dealuminization in accordance with Section 4.2.3.5.4 of ANSI/AWWA C509 and Section 4.2.3.3.4 of ANSI/AWWA C515.

C. Gaskets

1. Gaskets shall be free of asbestos and corrosive ingredients.

D. Shop Coatings.

Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy	
For Raw or Treated Water Service in potable water facilities (NSF certified systems)	PPG Amercoat "Amerlock 400 High-Solids Epoxy ", Carboline "Carboguard 891", Sherwin-Williams “Macropoxy 646NSF” or Tnemec "Series N140 Pota-Pox Plus".
For Liquid Service other than in potable water facilities	PPG Amercoat "Amerlock 385 Epoxy", Carboline "Carboguard 890", Sherwin-Williams “Macropoxy 646” or Tnemec "Series N69 Hi-Build Epoxoline II".
Rust-Preventive Compound	As recommended by manufacturer.
Universal Primer	As recommended by manufacturer

2.2 VALVE CONSTRUCTION

A. Ends

1. Valve ends shall be compatible with connecting piping and shall be as indicated in the Resilient-Seated Gate Valve Schedule. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of the governing standard.

2. Flanges shall be finished to true plane surfaces within a tolerance limit of 5 mils . The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per inch of flange diameter.

B. Stem Seals

1. The type of stem shall be as indicated in the Resilient-Seated Gate Valve Schedule. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems.

C. Rotation

1. The direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).

D. Shop Coatings

1. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. Except as specified below, the valve manufacturer's standard fusion-bonded coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating.

2. Surfaces shall be coated as follows:

Unfinished Surfaces

Interior Surfaces	Epoxy.
Exterior Surfaces of Valves to be Buried or Installed in Manholes or Valve Vaults	Coal tar epoxy or Epoxy.
Exterior Surfaces of Valves to be Submerged	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.

Polished or Machined Surfaces

Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy.

3. Alternatively, the manufacturer's standard coating may be used and the interior surfaces of each valve shall be subjected to a nondestructive holiday test in accordance with ASTM G62, Method A, and shall be electrically void-free.

4. Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10mils .
Universal Primer	3 mils .

2.3 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuator section and as indicated in the Resilient-Seated Gate Valve Schedule.

2.4 ACCESSORIES

A. When the Drawings or the Resilient-Seated Gate Valve Schedule indicate the need for extension stems, stem guides, position indicators, floor boxes, valve boxes, or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with Valve Installation section.

B. Installation Check

1. An installation check by an authorize representative of the manufacturer is not required.

End of Section

Schedule 40 05 61.23-S01
Resilient Seated Gate Valves Schedule

Tag Number	Size	Application	Type of Installation(1)	Ends(2)	Stem(3)	Type of Manual Actuator(4)	Extension Stems	Floor Boxes	Cast Iron Operating Stands	Fabricated Steel Operating Stands
	(in)									
COLW-VGR-1551	10	Clear Water	IP	f	OS&Y	HW	No	No	No	No
COLW-VGR-3001	8	Clear Water	IP	F	OS&Y	HW	No	No	No	No
COLW-VGR-3002	8	Clear Water	IP	F	OS&Y	HW	No	No	No	No

Notes:

(1) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
B	Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet (Bxx)
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SV	Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet(SVxx)
IP	In plant

(2) Abbreviations for types of ends:

F	Flanged
MJ	Mechanical joint
P	Push-on joint

(3) Abbreviations for types of stems:

NRS	Non-rising stem
OS&Y	Outside screw-and-yoke

(4) Abbreviations for types of manual actuators:

WN	Wrench nut
HW	Handwheel

END OF SCHEDULE

SECTION 40 05 62.13 - PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) plug valves.

B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in the Valve and Gate Actuator section.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Valves VP-1

VP-1	Rating	175 WOG

	Code	AGA Approved
Natural gas	Body	Cast iron
	Trim	
2-1/2 inch and	Plug Seal	Hycar
smaller pipe	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Threaded
	Temp. Limitations	-20 to 180°F
	Valve Operator	Lever
	Manufacturers	Key Port “Fig 425-RS51”

B. Valves VP-2

VP-2	Rating	175 WOG
	Code	AGA Approved
Natural gas	Body	Cast iron
	Trim	
3 and 4 inch pipe	Plug Seal	Hycar
	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Flanged, ASME B16.1, Class 125
	Temp. Limitations	-20 to 180°F
	Valve Operator	Lever
	Manufacturers	Key Port “Fig 425-RS51”

C. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

D. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuators section.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, and valves boxes shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 40 05 63.53 - MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) ball valves as specified herein.

B. Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.

C. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. General Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

B. Valves Type VB-10

VB-10 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller Socket	Rating	150 psig nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Socket
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve TBH Series"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co "True Union 2000 Standard Series 3600 Ball Valve"

C. Valves Type VB-11

VB-11 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section 4 inch and smaller Flanged	Rating	150 psig nonshock cold WOG
	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve TBH Series"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co. "True Union 2000 Standard Series 3600 Ball Valve"

D. Valves Type VB-14

[VB-14 Alloy 20 Stainless Steel for Sulfuric Acid Service (¼ to 4 inches)	Rating Code Type Body Trim Seat Ball Stem Thrust Washer Stem Seal End Connection Temp. Limitations Valve Operator Manufacturers	600 psig ANSI B16.34 In-line, 3-piece, bolted body, full port Carpenter 20 Cb-3 Reinforced Teflon Carpenter 20 Cb-3 Carpenter 20 Cb-3 Reinforced Teflon Teflon Socket Weld for valves 2" and smaller, Butt weld or flanged (Class 150) for valves 2 ½" and larger. Valves on storage tanks shall be flanged. -73 to 204°C Lever Conbraco Industries, Worcester Controls, or Neles Jamesbury

E. Valves Type VB-18

VB-18 Three-way ball valves in anti-siphon loop service 2 inch and smaller	Rating Type Body/Bonnet Trim Seat Ball Stem Thrust Washer Stem Seal Body Seals End Connection Temp. Limitations Valve Operator Manufacturers	150 psig nonshock cold WOG True union, three-way valve (Schedule 80) PVC or CPVC to match piping system Teflon PVC or CPVC to match piping system PVC or CPVC to match piping system PVC or CPVC to match piping system Teflon Viton O-rings Viton O-rings Socket 0 to 140°F Lever Asahi-America "Type 23 Multiport," Hayward "Three-Way Ball Valves," Nibco "3-Way Ball Valve," Spears "True Union 2000 Industrial 3-Way Valve"

F. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

G. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of all other valves	Universal primer.

2.2 VALVE ACTUATORS

A. Ball valve, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise specified or indicated on the drawings, each manual actuator shall be equipped with a lever operator. Ball valves with center lines more than 7'-6" above the floor shall be provided with chain levers.

B. Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2.3 ACCESSORIES

A. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 40 05 64.11 - AWWA BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing of AWWA butterfly valves for cold water service as indicated in the AWWA Butterfly Valve Schedule. All other butterfly valves are specified in the Industrial Butterfly Valves section.

B. AWWA butterfly valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all butterfly valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C504 **[**or ANSI/AWWA C516**]**.

E. Marking

1. Supplementing the requirements of Section 6.1 of the governing standard, the country of origin of all castings and an identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

F. Identification

1. AWWA butterfly valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

B. Drawings and Data – Electrical and Wiring Diagrams

1. Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

C. Certified Test Results.

1. Certified copies of test results for tests described in Section 5 of the governing standard, shall be submitted to Engineer before the valves are shipped. An affidavit of compliance with the governing standard for valves 72 inches and smaller and for valves 78 inches and larger shall be provided as indicated in Section 6.3 of ANSI/AWWA C504.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Butterfly valves shall be by the manufacturers listed below.

1. DeZurik
2. Pratt (Mueller)
3. M&H
4. Val-Matic
5. Rodney Hunt

2.2 MATERIALS

A. Except as modified or supplemented herein, materials used in the manufacture of butterfly valves shall conform to the requirements of the governing standard.

B. Acceptable shop coatings are listed in the following table.

Coal Tar Epoxy	High-build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy	
For Liquid Service other than in potable water facilities	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams "Macropoxy 646" or Tnemec “Series N69 Hi-Build Epoxoline II”.
For Raw or Treated Water Service in potable water facilities (NSF certified)	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams "Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

A. Valve Bodies

1. Valves shall be short-body type unless otherwise specified in the AWWA Butterfly Valve Schedule. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.

B. Flanges

1. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch . The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (0.017 percent) of flange diameter.

C. Mechanical Joint Ends

1. Mechanical joint ends shall be either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11.

D. Valve Shafts

1. Valve shafts shall be fabricated of AISI Type 304 or 316 stainless steel. The use of shafts having a hexagonal cross section will not be acceptable. The connection between shaft and disc shall be in accordance with the governing standard.

2. The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of set screws, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

E. Valve Seats

1. Seats for valves in filter air scour service shall be Viton rated for 300°F. Acceptable seating surfaces mating with rubber or Viton are AISI Type 304 or 316 stainless steel, monel, or plasma-applied nickel-chrome overlay for all valves; bronze for 20 inch and smaller valves; and alloy cast iron for 20 inch and smaller manually operated valves.

2. Seats shall be located on the valve body or disc. Valve seat configurations which rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

F. Shaft Seals

1. Shaft seals for valves in filter air scour service shall be Viton rated for 300°F.

G. Thrust Bearings

1. Each valve shall be provided with one or more thrust bearings in accordance with the governing standard. Thrust bearings which are directly exposed to line liquid and which consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable. Bearings for valves in filter air scour service shall be rated for 300°F.

2.4 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified herein, as indicated in the AWWA Butterfly Valve Schedule, and as specified in the Valve and Gate Actuators section.

B. All 8 inch and larger valves shall have geared actuators.

C. If valves with an AWWA class designation higher than specified are furnished, actuator torque capabilities shall be increased accordingly and shall be acceptable to Engineer.

D. Actuator Sizing

1. The valve manufacturer shall size the actuator in accordance with the governing standard , the operating conditions and requirements indicated in the AWWA Butterfly Valve Schedule, and the valve manufacturer's requirements.

2. Unless otherwise indicated or specified, actuator torque requirements shall be based on a maximum differential pressure across the valve equal to the maximum pressure associated with the valve class and a maximum velocity through the valve of 16 feet per second .

3. Valves with operating stands shall have actuator torques increased by 25 percent. Actuator torques determined by the above requirements shall be increased by any design factors required by paragraph 4.2.8 of ANSI/AWWA C504 or as specified herein.

2.5 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

B. Surfaces shall be painted as follows:

Unfinished Surfaces

Interior Surfaces	Epoxy.
Exterior Surfaces of Valves to be Buried or Installed in Manholes or Valve Vaults	Epoxy
Exterior Surfaces of Valves to be Submerged	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.

Polished or Machined Surfaces

Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy.

1. Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Coal Tar Epoxy	15 mils
Epoxy	10 mils
Universal Primer	3 mils

2.6 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, valve boxes, and extension bonnets shall be as indicated on the Drawings and as indicated in the AWWA Butterfly Valve Schedule and as specified in the Valve and Gate Actuators section.

PART 3 - EXECUTION

A. INSTALLATION

1. Valves shall be installed in accordance with the Valve Installation section.

End of Section

AWWA Butterfly Valves Schedule

Tag Number	Size	Application	Type of Installation(2)	AWWA Class(3)	Maximum Non-Shock Shutoff Pressure	Maximum Differential Pressure	Maximum Velocity	Type of Manual Actuator(4)	Limit Switches(6)
	(in)				(psi)	(psi)	(ft/s)		
COLW-VBF-1511	10	Cooling water pump no. 1	IP	150B-F	130	130		HW	
COLW-VBF-1512	10	Cooling water pump no. 2	IP	150B-F	130	130		HW	

Notes:

(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
Bxx	Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SVxx	Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet
IP	In plant

(3) Suffix letters define valve ends as follows:

F	Flanged
W	Wafer
MJ	Mechanical joint
S	Single Flange

(4) Abbreviations for actuator types are as follows:

WN	Wrench Nut
LVR	Lever
CW	ChainWheel
HW	HandWheel

(5) If a value is indicated, the leakage test shall be performed using this pressure value rather than the pressure indicated by the AWWA class.

(6) Abbreviations for limit switches on manual and cylinder operated valves.

EOT	End of travel (open - close)
PSS	Pump start - stop (two intermediate positions)
ELSCH	See electrical schematics

(7) Abbreviations for electronic or electric actuator housing.

WP	Weatherproof
SUB	Submersible [xx = depth of submergence] (SUBxx)
EXP	Explosion proof

(8) Cylinder actuators shall have torque safety factors applied in accordance with AWWA C504.

(9) Abbreviations for control devices are as indicated.

Table 1: Control Devices				
Abbreviations	Open-Close Push Button	Open-Stop- Close Push Button	Local-Off-Remote	Red and Green Indicator Lights
A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

(10) Abbreviations for electric actuator types are as follows:
SE Standard Electric
IE Intelligent Electric
NE Networked Electric

END OF SCHEDULE

(11) Abbreviation for remote control station types:
CS Control Station without Indicating Lights
CIS Control Station with Indicating Lights

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SECTION 40 05 67 - GLOBE VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) globe valves as specified herein.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Coordination

1. All equipment provided under this section shall be furnished by or through a single manufacturer who shall be responsible for the design, coordination, and satisfactory performance of all components over the full operating range.

E. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

F. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

A. Valves VGL-1

VGL-1 Service as indicated on the plumbing drawings. 3/4 inch through 2 inch pipe	Rating	Class 125
	Code	MSS SP-80, Type 1
	Type	In-line, metal disc, threaded bonnet, rising stem
	Body/Bonnet	Lead free ASTM B584, bronze
	Trim	
	Seat	Integral to body
	Disc	Lead free Bronze or Brass
	Stem	Lead free Bronze or Brass
	Bonnet Gasket	Manufacturer’s standard
	Stem Packing	Manufacturer’s standard
	End Connection	Threaded
	Temp. Limitations	0 to 350°F
	Valve Operator	Handwheel
	Manufacturers	Apollo “120T LF”, Milwaukee “UP502”, or equal.

B. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

C. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".

Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS

A. Unless otherwise specified, globe valves shall be provided with handweel type manual actuators. Handwheel diameter shall be manufacturers standard size.

B. Unless otherwise specified, valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 or Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides; position indicators; floor boxes; valve boxes; and operating stands shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

SECTION 40 05 68 - CHECK VALVES

1.1 SCOPE

A. This section covers the furnishing of check valves as specified herein.

B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Temporary Number Plates

1. Each check valve with an identifying number listed in the Check Valve Schedule, shall be tagged or marked in the factory with the identifying number.

E. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

A. Valves VC-9

VC-9 High pressure clear water service 3 through 12 inch pipe	Rating	Class 250
	Type	Dual disc wafer
	Body/Bonnet	ASTM A126, Class B, cast iron
	Trim	
	Seat	Buna-N
	Disc	ASTM B148 Alloy 952, aluminum bronze
	Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
	Bearings	Teflon
	End Connection	Plain, installed between ASME B16.1, Class 250, raised faced flanges
	Temp. Limitations	-20 to 225°F intermittent, 0 to 180°F continuous
	Manufacturers	Stockham "WG-970", "Duo-Chek II Figure 30HMF", Apco Valve and Primer "9200AR1R"

B. Valves VC-13

VC-13 Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section Socket ends 3 inch and smaller PVC or CPVC pipe	Rating	150 psig nonshock
	Type	Ball check, true union
	Body	PVC or CPVC, material shall match pipe material
	Trim	
	Ball	PVC or CPVC, material shall match pipe material
	Seat	Viton or EPDM
	Seals	Viton or EPDM
	End Connection	Socket
	Temp. Limitations	0 to 140°F
	Manufacturers	Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", Spears Manufacturing Co. "True Union 2000 Industrial Series 4500 Ball Check Valves"

C. Valves VC-14

VC-14 Service as specified in Miscellaneous	Rating	150 psig nonshock
	Type	Ball check, true union
	Body/Bonnet	PVC or CPVC, material shall match pipe material
	Trim	

Plastic Pipe, Tubing, and Accessories Section Flanged ends 3 inch and smaller PVC or CPVC pipe	Ball	PVC or CPVC, material shall match pipe material
	Seat	Viton or EPDM
	Seals	Viton or EPDM
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	0 to 140°F
	Manufacturers	Hayward Plastics Products “Ball Check Valve”, Nibco “Chemtrol True Union Ball Check Valve”, Spears Manufacturing Co. “True Union 2000 Industrial Series 4500 Ball Check Valves”

D. Valves VC-17

VC-17 Chemical piping vacuum relief service PVC or CPVC pipe	Rating	100 psig nonshock
	Type	Diaphragm, two piece
	Body	PVC
	Trim	
	Diaphragm	Chemical resistant
	End Connection	Threaded
	Temp. Limitations	0 to 140°F
	Manufacturers	Plast-O-Matic “Series CKM Check Valves” or “Series VB Vacuum Breakers”

E. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard°891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish or coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Schedule 40 05 68-S01
Check Valves Schedule

Tag Number	Size	Type of Valve	Service	Design Capacity	Ends(1)
	(in)			(gpm)	
COLW-VCK-1511	8	VC-9	Cooling Water Pump No. 1	800	F
COLW-VCK-1512	8	VC-9	Cooling Water Pump No. 2	800	F

Schedule 40 05 68-S01
Check Valves Schedule

Notes:

(1) Abbreviations for valve ends are as indicated:

F	Flange
MJ	Mechanical Joint
P	Plain

END OF SCHEDULE

SECTION 40 05 73.13 - PRESSURE REDUCING AND PRESSURE SUSTAINING VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of pressure reducing and pressure sustaining valves as specified herein.

B. Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Net weight of each valve and accessory
b. Name of manufacturer.
c. Type and model.
d. Construction materials and finishes.
e. Unit dimensions.
f. Performance curves indicating flow capacity versus pressure drop.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Pressure reducing and pressure sustaining valves shall be designed to meet the service requirements as indicated herein and in the Pressure Reducing and Pressure Sustaining Valves Schedule.

B. Each pressure reducing valve and pressure sustaining shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the pressure setpoint.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2.3 MATERIALS

A. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel, NSF certified (Liquid Service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Epoxy Enamel (Gas and Air Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".

2.4 CONSTRUCTION.

A. Water Service

1. Pressure Reducing Valves

a. Pressure reducing valves for water service shall be direct-acting or pilot-operated type as indicated in the Pressure Reducing Valve Schedule.
b. Direct-acting valves shall be globe type with threaded connections and union assembly. The valves shall be provided with bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel strainer. Direct-acting pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, or Watts.
c. Pilot-operated valves shall be globe type with flanged ends. The valves shall be provided with epoxy coated ductile iron body, bronze trim, and Buna-N rubber diaphragm and disc. The pilot regulating valve shall be bronze with stainless steel trim. Pilot-operated pressure reducing valves shall be Cla-Val “Model 90-01”, Watts, or OCV.
d. When indicated in the schedules, pilot-operated valves shall be equipped with a low flow bypass. The low flow bypass shall consist of a direct-acting pressure reducing valve in parallel with the pilot-operated valve. The valves and required piping assembly shall be factory assembled and shall be Cla-Val “Model 90-48”, Watts, or OCV.

2. Pilot Operated Anti-Cavitation Pressure Sustaining Valves

a. Pilot-operated valves shall be globe type with flanged ends. The valves shall be provided with epoxy coated ductile iron body, bronze trim, and Buna-N rubber diaphragm and disc. The pilot regulating valve shall be bronze with stainless steel trim. Pilot-operated anti-cavitation pressure sustaining valves shall be Cla-Val “Model 50-01 KO” or equal.
b. The pilot system shall include a strainer. The full range of spring settings shall be available in ranges of 0-450 psi. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.
c. Equip valve with pressure gauge for monitoring field adjustments.
d. The valve shall be hydraulically operated, pilot-controlled, modulating type designed to maintain a minimum constant upstream pressure within close limits.

B. Gas Service

1. Pressure reducing valves for natural gas and propane gas service shall be suitable for gases with specific gravities of 0.6 and 1.5, respectively. Natural gas and propane gas pressure reducing valves shall be direct-acting type with cast iron or cast steel bodies, threaded ends, aluminum trim, and a nitrile diaphragm and disc. Valves shall be Fisher Controls "HSR or CS400 Series".

C. Air Service

1. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be provided with flanged or socket weld connections. Socket weld locations shall be at sufficient to prevent damage to elastomeric valve components. Valves shall be as manufactured by Fisher Controls; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or equal.

2.5 SAFETY VALVES FOR AIR SERVICE

A. Safety valves for air service shall be ASME labeled and shall have carbon steel bodies with stainless steel seats and discs, packed lifting levers, and integral spring enclosures. Gauges shall be provided for all valves. The safety valves shall be located as indicated on the drawings. The safety valves shall be as manufactured by Consolidated or Crosby.

B. Safety Valves shall be selected and sized as recommended by the valve manufacturer. Safety valves shall be installed downstream from pressure reducing valves.

Valve Tag No.	Install downstream from pressure reducing valve

C. Safety valves shall be suitable for operation under the following conditions:

Performance and Design Requirements				
Service	Air	Air	Air	Air
Tags Nos.				
Specific gravity of gas	1.0	1.0	1.0	1.0
Minimum design rating, psig				
Pressure relief setting, psig				
Capacity, scfm				
Actual size to be confirmed and selected by valve manufacturer.				

2.6 SHOP PAINTING

A. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection in accordance with the following list. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Protective Coatings section.

Interior Surfaces

Liquid Service	Epoxy (NSF certified).
Gas and Air Service	Epoxy.
Exterior Surfaces	Universal primer with epoxy finish coat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

End of Schedule]

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Schedule 40 05 73.13 S01 - Pressure Reducing and Pressure Sustaining Valves Schedule

Tag Number	Location	Type of Servic(1)	Type(2)	Maximum Inlet Pressure	Minimum Inlet Pressure	Pressure Setting	Maximum Flow(3)	Ordinary Flow(3)	Minimum Flow(3)	Minimum Permissible Pressure at Maximum Flow
				(psig)	(psig)	(psig)	(3)	(3)	(3)	(psig)
COLW-VPC-3000	COOLING WATER VALVE AND INSTRUMENTATION STATION	W	POPS			91	800	500	200	

Notes:

(1) Abbreviations for types of service are as follows:

W Water
NG Natural Gas
PG Propane Gas
DG Digester Gas
A Air

(2) Abbreviations for Pressure reducing value type are as follows:

DOPR Direct-operated Pressure Reducing
POPR Pilot-operated Pressure Reducing
DOPS Direct-operated Pressure Sustaining
POPS Pilot-operated Pressure Sustaining

(3) Units of flow are as follows:

Water service	Gallons per minute (gpm) (Liters per second [L/s])
Gas Service	Cubic feet per hour (cfh) (Cubic meters per second [cms])
Air Service	Cubic feet per minute (cfm) (cubic meters per second [cms])

End of Schedule

SECTION 40 05 84.11 - PINCH AND DIAPHRAGM VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) or modulating pinch and diaphragm valves.

B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in the Valve and Gate Actuator section.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittal Procedures section.

PART 2 - PRODUCTS

2.1 DIAPHRAGM VALVE CONSTRUCTION

A. Valves VD-1

1. Diaphragm valves used in sodium hypochlorite service shall be provided with socket weld ends. Flanged ends may be used where required to facilitate disassembly of piping or equipment, or where acceptable to the Engineer.

VD-1 Sodium Hypochlorite service	Rating	Class 150
	Body	CPVC
	Trim	Two-piece unbonded, Teflon and EPDM
	Diaphragm	Socket weld, flanged, ASME B16.1, Class 125, flat faced
	End Connection	Handwheel with travel-stop & position indicator
	Operator	Asahi/America “Type G”, “Type 14 Diaphragm Valves”, or “Type 15 Diaphragm Valves”, ITT “Dia-Flo Valves”
	Manufacturers	

2.2 VALVE ACTUATORS

A. Manual actuated valves shall be provided with handwheels as specified herein. Requirements for automatic valve actuators shall be as specified herein**,** and as specified in the Valve and Gate Actuators section.

B. Manual Actuators

1. Manual actuators of the types listed herein shall be provided by the valve manufacturer.

2. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

3. The direction of rotation of the wheel to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.

C. Handwheels

1. Handwheel diameters shall be as recommended by the valve manufacturer.

D. Chainwheels

1. Unless otherwise specified in the valve schedules, all valves with center lines more than 7'-6" above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet of the floor below the valve.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, and valve boxes shall be as specified in the Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 40 05 86 - AIR VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing air-release valves , combination air valves, and air/vacuum valves as indicated in the Air Valve Schedule.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable performance requirements of ANSI/AWWA C512.

E. Identification

1. Air valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Air release valves for clean water applications with operating pressures of 150 psi or less shall be Apco/Valve and Primer "No. 200", GA Industries "Figure 920m", Multiplex "Crispin Type PL", ARI “No. S-050”, or Val-Matic "No. 38". Air release valves for working pressures below 20 psi shall be provided with soft seats.

B. Air release valves for clean water applications with operating pressures greater than 150 psi shall be Apco/Valve and Primer "No. 200A", GA Industries "Figure 920-H", Multiplex "Crispin Type PL", ARI “No. S-050”, or Val-Matic "No. 38".

C. Three inch and smaller air release and vacuum relief valves for clean water applications shall be integral type, Apco/Valve Primer “Series 140”, Multiplex “Crispin AL Series”, or Val-Matic “Air/Vacuum Valves”.

D. Two inch and smaller combination air valves for clean water applications shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", ARI “No. D-040”, or Val-Matic "Combination Air Valves". Unless otherwise specified or indicated on the Drawings, valves shall be provided with surge check discs on the valve inlet to restrict the exhaust air flow rate.

E. Two inch and smaller air release and vacuum relief valves for vertical diffusion vane pumps shall be of the kinetic energy type with a valve assembly which functions as both an air release and a vacuum relief valve. The exhaust from the valve shall be provided with a throttling device for field adjusting the air flow rate. The valves shall be Apco/Valve and Primer "Series 140DAT Air Valves for Vertical Turbine Pumps", GA Industries "Figure 933 Kinetic Air/Vacuum Valve", ARI “No. D-040”, or Multiplex "Crispin Deep Well Air Valve". The discharge from the valve shall be provided with a threaded NPT connection.

2.2 MATERIALS

A. Except as modified or supplemented herein, materials of construction shall comply with the governing standard.

Valve Trim	Bronze or austenitic stainless steel or polymer materials. Valve trim for valves in wastewater service shall be austenitic stainless steel.
Float	Austenitic stainless steel, polycarbonate, or foamed polypropylene.
Shop Coatings	
Epoxy (ANSI/NSF-61 and	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams

ANSI/NSF 600 Certified)	"Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.
Epoxy	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams "Macropoxy 646" or Tnemec “Series N69 Hi-Build Epoxoline II”.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating. Field painting is covered in the Protective Coatings section.

B. Surfaces shall be painted as indicated:

Interior Surfaces of Valves in Clean Water Applications (Raw or Treated Water in Potable Water Facilities)	ANSI/NSF-61 and ANSI/NSF 600 Certified Epoxy.
Interior Surfaces of Valves in Wastewater Applications	Epoxy
Exterior Surfaces of Valves To Be Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

C. Interior epoxy coatings for clean water valves shall comply with ANSI/AWWA C550/NSF 61 and ANSI/NSF 600. Interior coatings for all valves shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils
Universal Primer	3 mils

2.4 SHUTOFF VALVES

A. A shutoff valve shall be provided in the piping leading to each air valve. Shutoff valves 2 inches and smaller shall be ball valves as specified in the Miscellaneous Ball Valves section.

Shutoff valves 3 inches and larger for clean water service shall be butterfly valves as specified in the AWWA Butterfly Valve section. Shutoff valves 3 inches and larger for wastewater service shall be eccentric plug valves as specified in the Eccentric Plug Valve section.

B. Each 4 inch and larger combination air valve shall be provided with a shutoff valve between the air and vacuum valve and the air release valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Air release and combination air valves shall be installed in accordance with the Valve Installation section.

End of Section

Tag Number	Type(1)	Location(2)	Inlet size	Outlet Size	Orifice Size	Inlet Type(3)	Outlet Type(4)	Working Pressure	Location in exisitng pipeline W63C*
			(in)	(in)	(in)			(psi)	(Sta)
COLW-AVRV-1011	CAV	IV	1	1	5/16	T	T	5	112+25
COLW-AVRV-1012	CAV	IV	1	1	5/16	T	T	5	112+25
COLW-AVRV-1013	CAV	IV	1	1	5/16	T	T	5	114+50
COLW-AVRV-1014	CAV	IV	1	1	5/16	T	T	5	114+50
COLW-AVRV-1021	CAV	IV	1	1	5/16	T	T	5	132+60
COLW-AVRV-1022	CAV	IV	1	1	5/16	T	T	5	132+60
COLW-AVRV-1023	CAV	IV	1	1	5/16	T	T	5	134+60
COLW-AVRV-1024	CAV	IV	1	1	5/16	T	T	5	134+60
COLW-AVR-1500	ARV	IP	1/2		1/16	T	T	150	N/A
COLW-AVRV-1510	ARVR	IP	2	2	-	T	T	150	N/A
COLW-AVRV-1520	ARVR	IP	2	2	-	T	T	150	N/A
COLW-AVR-3000	ARV	IP	1	-	5/16	T	T	3	N/A

* See Project No.101-W63 drawings by Nelson & Co., 2018, and coordinate with Engineer for location and access. Install per Detail F on C-99-506.

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SECTION 40 05 93 - COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1).

B. Motors shall be designated and coordinated with the driven equipment and shall be located as indicated on the Drawings.

1.2 GENERAL

A. Motors furnished under driven equipment Specification sections shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

B. Where applicable, individual motor data sheets have been developed which specify additional requirements for specific motors.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all motors, unless otherwise specified. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Motors furnished under this section shall be designed, constructed, and tested in accordance with the latest version of NEMA MG 1, NEMA MG 10, and IEEE 112, Test Method B.

F. Nameplates

1. All motor nameplate data shall conform to NEMA MG 1 requirements.

1.3 SUBMITTALS

A. Drawings and Data - General

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

B. Drawings and Data – Each Motor

1. Name of manufacturer.
2. Type and model.
3. Type of bearing and method of lubrication.
4. Rated size of motor, hp, and service factor.
5. Temperature rise and insulation rating.
6. Full load rotative speed.
7. Net weight.
8. Efficiency at full, 3/4, and 1/2 load.
9. Full load current.
10. Locked rotor current.
11. Space heater wattage, where applicable.
12. Motor temperature switch data, where applicable.
13. Motor Shaft Grounding Ring data, where applicable.
14. RTD data, where applicable.
15. Reed critical frequency data (for vertical motors 400 hp and larger)

C. Seismic Design Requirement Certifications

1. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS

A. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

B. Operation and maintenance manuals shall include the following:

1. Assembly, installation, alignment, adjustment, and checking instructions.

2. Lubrication and maintenance instructions.

3. Guide to troubleshooting.

4. Parts lists and predicted life of parts subject to wear.

5. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

6. Test data and performance curves, where applicable.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Service conditions for motors shall be as specified in the driven equipment Specification sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. Where site elevation and ambient temperature is not specified in the driven equipment Specification sections, the motors shall be designed for the following.

Site elevation	Below 3,300 ft
Ambient temperature	40 °C

B. Unless specified otherwise, all motors shall be designed for full voltage starting and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

C. Motors utilizing a reduced-voltage, autotransformer starter shall be capable of reduced-voltage starting at a 65 percent tap setting.

D. Motors utilizing a reduced voltage solid state starter shall be capable of starting at 50% of the specified voltage.

E. When powered from an adjustable frequency drive (AFD), motors shall be inverter duty and specifically selected for service with an adjustable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when

operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by AFDs shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

F. The number of starts per hour for motors shall be rated for the load cycling requirements of NEMA MG 10.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless otherwise specified in the attached motor data sheet(s), design and construction of each general-purpose motor shall be as specified herein. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

Motor voltage.	460, 3 phase for ½ horsepower and larger, 120, single phase for smaller than ½ horsepower
Frequency.	60 Hz
Speed.	Constant speed
Service factor.	1.0 , except for AFD driven motors which shall be 1.15
Insulation class and temperature rise above 40° C design ambient (by resistance method.	Class F with 80° C rise at 1.0 SF
Enclosure.	Totally enclosed fan cooled
Main conduit box sized to include.	Main motor leads and space heater leads where space heaters are specified

B. Nameplate Horsepower

1. Motor nameplate horsepower [kW] shall be equal to or greater than the maximum load imposed by the driven equipment.

C. Enclosures

1. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

2. Totally Enclosed Motors

a. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be

fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be UL approved.

3. Outdoor Motors

   a. Outdoor motors shall have NEMA weather protected enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion resistant polyester coating. Exposed uncoated surfaces shall be of a corrosion resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion resistant polyester, polyurethane or epoxy coating.

4. Motors for Hazardous Locations

   a. Motors for hazardous locations shall be in accordance with the NEC and of the correct type enclosures for the particular service as specified in NEMA MG 1. Motors shall meet the requirements of UL 674.

5. Encapsulated Windings

   a. Where specified in the motor data sheet(s), motors shall be provided with encapsulated windings meeting the requirements of NEMA MG1-1.27.2.

6. Severe Duty Chemical Service Motors

   a. Where specified in the motor data sheet(s), motors shall be provided with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG1-1.27.2 and IEEE 841.

D. Main Conduit Boxes

1. The main conduit box shall be in accordance with NEMA MG 1. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line Drawings.

2. The main conduit box shall be oversized at least one size larger than NEMA standard. The main conduit box shall be sized for all indicated accessory leads.

3. Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

E. Leads

1. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their

terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.

2. All motors rated 100 horsepower and larger, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

3. Leads for dual-voltage rated or for multispeed motors shall be easily connected or reconnected in the main conduit box for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the main conduit box or on the motor frame or nameplate.

F. Terminals

1. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.

G. Grounding Connections

1. All motors shall be furnished with a ground connection.

H. Bearings

1. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.

2. Motor bearings shall be antifriction type with L_{10} life rating of 40,000 hours in accordance with ABMA Standards.

3. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.

4. Insulated Bearings

a. Motors over 100 horsepower controlled by an adjustable frequency drive shall be furnished with one insulated bearing. The insulated bearing shall be installed on the non-drive end of the motor.

I. Rotors

1. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec or less.

J. Shafts

1. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

K. Torque Characteristics

1. Motors rated 200 horsepower and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.

L. Motor Space Heaters

1. Unless otherwise specified in the attached motor data sheet(s), motors 1 horsepower and larger shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

M. Temperature Sensing Devices

1. Each motor controlled by an adjustable frequency drive shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amps at 120 volts ac. The contacts shall be wired in series with the end leads brought out to the motor terminal box.

N. Motor Shaft Grounding Ring

1. Each motor controlled by an adjustable frequency drive shall be furnished with a maintenance free, conductive micro fiber, shaft grounding ring with circumferential micro fibers to discharge electrical shaft currents within the motor. Motor shaft grounding ring shall be installed on the drive end on the motor shaft. Shaft grounding ring shall be installed by the motor's manufacturer in accordance with grounding ring manufacturer's recommendations.

O. Assembly

1. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

P. Efficiency

1. Unless otherwise specified in the attached motor data sheet(s), motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

2. Vertical motors shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
0.7	1	84.0	85.5	82.5	75.0	77.0	85.5	82.5	75.5
1.1	1.5	84.0	86.5	86.5	78.0	84.0	86.5	87.5	80.0
1.5	2	85.5	86.5	87.5	86.5	85.5	86.5	88.5	85.5
2.2	3	85.5	89.5	88.5	89.5	87.0	89.5	89.5	86.5
3.7	5	86.5	89.5	89.5	89.5	88.5	89.5	89.5	85.5
5.6	7.5	88.5	91.0	90.2	88.5	90.0	91.7	91.0	86.5
7.5	10	89.5	91.7	91.7	91.0	91.0	91.7	91.0	91.0
11.2	15	90.2	93.0	91.7	91.0	91.0	92.4	92.0	91.0
14.9	20	91.7	93.0	92.4	92.0	92.0	93.0	92.0	91.0
18.7	25	92.4	93.6	93.0	92.0	92.0	93.6	93.0	91.0
22.4	30	93.0	94.1	93.6	93.0	92.4	93.6	93.0	93.0
29.8	40	93.0	94.1	94.1	93.0	92.4	94.1	94.1	93.0
37.3	50	93.0	94.5	94.1	93.0	93.0	94.5	94.1	93.0
44.8	60	93.6	95.0	94.5	94.0	93.6	95.0	94.5	93.0
56	75	94.0	95.0	95.0	94.0	93.6	95.4	95.0	94.0
74.6	100	94.5	95.4	95.0	95.0	94.1	95.4	95.0	94.0
93.2	125	95.0	95.4	95.0	95.0	95.0	95.4	95.0	94.0
112	150	95.0	95.8	95.4	95.0	95.0	95.8	95.8	94.0
149	200	95.4	95.8	95.4	95.0	95.4	96.2	95.8	94.1
186	250	95.0	95.8	95.4	95.0	95.8	96.2	95.8	94.5
224	300	95.4	95.8	95.4		95.8	96.2	95.8	
261	350	95.4	95.8	95.4		95.8	96.2	95.8	
298	400	95.8	95.8	95.8		95.8	96.2	95.8	
336	450	95.8	96.2	96.2		95.8	96.2	95.8	
373	500	95.8	96.2	96.2		95.8	96.2	95.8	

2.3 ACCESSORIES.

A. Special Tools and Accessories

1. Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2.4 ANCHORS

A. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2.5 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required by NEMA MG 1. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

B. Vertical pump motors 400 hp and larger shall be tested, by means of a bump test, at the factory after fabrication for final reed critical frequency (RCF). A report comparing the bump test RCF results with calculated RCF [per NEMA MG 1] shall be produced. The RCF comparison report shall be sent to the pump manufacturer and a copy also included with the other motor test reports during shipment. If more than one (1) identical motor is included in the scope of supply, only one motor of each type shall require the RCF bump testing. The RCF comparison report information shall be included in each of the test reports for all identical motors in the scope of supply.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each motor shall be installed in accordance with the Equipment Installation section.

End of Section

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SECTION 40 06 20 - SCHEDULES FOR LIQUIDS PROCESS PIPING

1. SCOPE

This section consists of a schedule of 4 inch and larger pipelines indicating the type of pipe to be used. Pipe materials, installation, testing, and disinfection, when specified, are covered in other sections.

Piping smaller than 4 inch is covered in the various miscellaneous piping sections. Piping for plumbing, heating and air conditioning systems is covered in other sections. Piping to be furnished with equipment is covered in the applicable equipment section.

2. ALTERNATIVE PIPE TYPES

Where more than one type of pipe is indicated in the schedule, the type of pipe material to be installed may be selected by Contractor. The details on the drawings cover only one type of pipe for each line. If a different material is selected by Contractor, all details of connections, jointing, wall fittings, support, anchorage, and harnesses shall be modified as necessary to produce an equivalent design acceptable to Engineer.

3. WALL FITTINGS

A wall pipe or sleeve will be required for all pipe passing through concrete or masonry block walls. Wall fittings and sleeves shall be as indicated on the drawings and as specified in the applicable piping section.

4. SCHEDULE INDEX

Pipe material abbreviations and their applicable specification section number are as indicated:

Abbreviation	Pipe Material	Section No.
BR	Brass	40 05 41
CI	Cast iron soil pipe	22 13 16
CPVC	CPVC	40 05 32
CS	Miscellaneous steel pipe	40 05 24.43
CU	Copper tubing	40 05 17
DIP	Ductile iron pipe	40 05 19
FRP	FRP	40 05 32
HS	Hose	40 05 41
LWSP	Light wall steel pipe	40 05 24.14
PE	Polyethylene	40 05 32

Abbreviation	Pipe Material	Section No.
PP	Polypropylene	40 05 32
PVC	PVC	40 05 32
PVCSP	PVC sewer pipe	40 05 31.16
PVDF	PVDF	40 05 32
RPT	Reinforced plastic tubing	40 05 32
TG	Tempered glass	40 05 41

5. SCHEDULE

Pipe materials shall conform to Schedule 40 06 21-S01. All pipelines indicated on the drawings and all pipelines required for proper operation of the equipment furnished shall be provided whether listed in the schedule or not.

End of Section

Schedule40 06 20 -S01

Pipeline Schedule

1.000	**General**
1.010	Specification Section 40 06 20
2.000	**Requirements**

Size in.	Service	Location	Material
4” and larger	Sanitary Sewer	All	PVCSP
4” and larger	Outfall Sewer	From Chlorine Contact Basin to MH-02	DIP
4” and larger	Outfall Sewer	From MH-02 to Outfall Headwall	PVCSP
4” and larger	Cooling Water	All	DIP
4” and larger	Treated Effluent	Buried	DIP
4” and larger	Pond Effluent	Buried	DIP
4” and larger	Drain	Buried	DIP
4” and larger	PW & Fire Service	All	DIP

End of Schedule

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SECTION 40 42 11 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of insulation, jackets, and accessories for the following mechanical systems:

1. Piping
2. Ductwork
3. Equipment

B. Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

C. Electrical heat tracing for piping shall be as specified in the Electrical section.

1.2 GENERAL

A. Materials furnished and installed under this section shall be in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall be responsible for coordinating the installation of insulation with the installation of the items or systems to be insulated. Each item or system shall be tested and accepted by Engineer before installation of the insulation materials.
2. Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.
3. All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL, NFPA, and ASTM safety requirements.

E. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

F. Surface Burning Characteristics

1. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

G. Painting and Identification

1. Field painting and identification shall be as specified in the Protective Coatings section.

2. Piping systems with electrical heat tracing shall have warning labels attach to the outside of the pipe thermal insulation weather barrier to indicate the presence of electric heat tracing. Labels shall be located every 10 feet of pipe, alternating on either side. The labels shall be black on yellow, weatherproof, mylar, with pressure sensitive adhesive and at least 2 inches by 6 inches minimum.

1.3 SUBMITTALS

A. Drawings and Data

1. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance with the Submittals Procedures section. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

2. Product data for adhesives shall include VOC content.

1.4 QUALITY ASSURANCE

A. Manufacturer Experience

1. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.2 MATERIALS

A. Insulation, vapor retarders, and field applied jackets shall be installed to cover piping, ductwork, equipment, fittings, and appurtenances as indicated in the Insulation Schedule.

B. Pipe Insulation

1. Type PMF1 Insulation

a. Type PMF1 mineral fiber pipe insulation shall be Johns Manville "Micro-Lok", Knauf "Pipe Insulation" or Owens-Corning.
b. Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F , shall have a maximum thermal conductivity (k) of 0.24 Btu in/hr ft2 °F at 75°F , and shall conform to ASTM C547.

2. Type PMW1 Insulation

a. Type PMW1 high temperature mineral wool pipe insulation shall be Rock Wool Manufacturing Company “Delta-PC”.
b. Type PMW1 pipe insulation shall be a high temperature, sectional or segmented mineral wool forms with thermosetting binder suitable for temperatures up to 1200°F , and shall be provided in multiple layers. Fittings and valves shall be insulated with factory-made molded fiber fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C547.

3. Type PFC1 Insulation

a. Type PFC1 flexible cellular elastomeric pipe insulation shall be Armacell "AP/Armaflex" or K-Flex USA "Insul-Tube" for unslit insulation and Armacell “AP/Armaflex SS” or K-Flex USA “Insul-Lock Seam-Seal” for factory pre-slit insulation. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or Plastic Technology, Inc. “Innofoam”.
b. Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 180°F , and shall have a maximum thermal conductivity (k) of 0.28 Btu in/hr ft2 °F at 75°F . The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. Insulation shall conform to ASTM C534 for elastomeric or ASTM C1427 for polyolefin.

C. Duct Insulation

1. Type DMF2 Insulation

a. Type DMF2 flexible type duct insulation shall be Johns Manville "Microlite", Knauf "Friendly Feel Duct Wrap", or Owens-Corning “SOFTR All-Service Duct Wrap”.
b. Type DMF2 exterior insulation for round ductwork shall be 1 lb per cubic foot density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 250°F , and shall have a maximum thermal conductivity (k) of 0.27 Btu in/hr ft2 °F at 75°F . The insulation shall conform to ASTM C553.

D. Equipment Insulation

1. Type EMF1 Insulation

a. TypeEMF1 equipment insulation shall be Johns Manville "800 Series Spin-Glas", Knauf "Insulation Board", or Owens-Corning “Fiberglas 705”.
b. Type EMF1 equipment insulation shall be rigid mineral fiber insulation board with a density of 6 pounds per cubic foot and a factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 150°F , and shall have a maximum thermal conductivity (k) of 0.23 Btu in/hr ft2 °F at 75°F . The insulation shall conform to ASTM C612.

2. Type EMW1 Insulation

a. Type EMW1 equipment insulation shall be Rock Wool Manufacturing Company “Delta-12 Mineral Wool Board".
b. Type EMW1 equipment insulation shall be high temperature mineral wool board with a thermosetting binder suitable for temperatures up to 1200°F and shall have a density of 12 pounds per cubic foot . The insulation shall conform to ASTM C592.

2.3 ACCESSORIES

A. PVC Insulation Jackets

1. PVC insulation jackets for piping systems shall be furnished and installed as specified herein and indicated on the Drawings.

2. All fittings in piping systems insulated with mineral fiber shall be jacketed with a polyvinyl chloride (PVC) jacketing material. Piping systems where indicated to have PVC jackets shall be jacketed with the same PVC jacketing material. Jackets for fittings shall be one piece, factory molded to the contour of the fitting. The PVC jacket and fitting covers shall have a minimum thickness of 0.020 inches when installed indoors and 0.030 inches when installed outdoors. PVC jacketing shall be Johns Manville "Zeston 2000 Series".

B. Aluminum Insulation Jackets

1. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as indicated in the insulation schedule herein and where indicated on the Drawings. Aluminum jackets shall be manufactured from **[**alloys 3003 and 3105**][**alclad**]** conforming with ASTM B209. The aluminum jacket shall have a nominal thickness of **[**0.016 in. **][**0.020 in. **][**0.024 in. **][**0.032 in. **]**, with an embossed finish.

2. Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The jacket shall have a factory-applied moisture retarder of at least 3 mils permanently bonded to the interior surface and extending the full width of the jacket. The retarder shall consist of Polysurlyn or polyethylene film and kraft paper.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. General

1. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. All work shall be performed within the temperature ranges recommended by the insulation product manufacturer. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

2. Seams of exposed insulation and jackets shall be in the least visible location.

3. All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.

B. Piping Insulation

1. Type PMF1 Insulation

a. Pipe insulation, vapor retarders, and field applied jackets shall be installed to cover system piping, fittings, and appurtenances. Insulation shall be full factory unit lengths using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.

b. Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet for straight runs and not more that 6 inches from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

c. On piping 2 inches and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

2. Type PMW1 Insulation

a. The insulation shall be installed in layers to obtain the specified thickness. Joints and seams between insulation sections or segments shall be tight and shall be staggered between layers. The insulation shall be shall be fastened with stainless steel wire loops on 6 inches centers embedded into the outer layer. All cracks, voids, and depressions shall be filled with insulating cement suitable for the system operating temperatures. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and expansion joints in exhaust piping shall not be insulated.

3. Type PFC1 Insulation

a. Pipe insulation shall be installed to cover all pipe, fittings, and appurtenances with all seams and joints sealed by a factory or field applied adhesive. Insulation at fittings and appurtenances shall be carefully formed and fitted. Insulation at elbows shall be mitered using segments of pipe insulation.

C. Duct Insulation

1. Insulation for ducts indicated on the Drawings as wrapped shall be installed as specified herein and indicated on the Drawings. Duct insulation shall be continuous through

hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

2. Insulation on ducts conveying air at temperatures below 60°F shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3. Type DMF2 Insulation

a. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches and shall be secured under the overlap with adhesive and stapled on 4 inch centers.

D. Equipment Insulation

1. Insulation for equipment shall be installed as specified herein and indicated on the Drawings. Equipment insulation shall be installed and fastened as recommended by the manufacturer.

2. Equipment insulation shall be installed in as closest contact possible with the equipment surface and shall be secured with studs, pins, clips, adhesives, wires, or bands. Pumps may be insulated by forming a box around the pump housing. Seams shall be sealed with joint sealing tape. A smooth coat of insulation cement shall be applied over the insulation except at removable sections. On equipment with surface temperatures lower than 60°F , two coats of vapor barrier coating shall be applied.

3. Equipment insulation shall be applied with interruptions for access to manholes, flanges, and other openings without disturbing the insulation. Boxouts with beveled and sealed edges shall be provided around code stamping symbols and nameplates.

E. PVC Jacketing

1. PVC jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. End joints and longitudinal seams on piping systems conveying fluids at lower than ambient temperatures shall be vapor-sealed, and covered with vapor-barrier tape to ensure a continuous vapor seal. Fittings shall be insulated with glass fiber material.

F. Aluminum Jacketing

1. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches to produce tight joints without "bulging". The jacket shall overlap at least 2 inches at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.

2. Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

3.2 INSULATION SCHEDULE.

INSULATION SCHEDULE				
		Mechanical Insulation		
Service	Size Inches	Type	Thickness Inches	Notes
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Compressed Air	All	PMF1	1	(1)
Condensate Drain	All	PMF1	1	(3)
Non-Potable Cold Water	Up to 3 4 & larger	PFC1 PFC1	3/4 1	(3) (3)
Potable Cold Water	Up to 3 4 & larger	PFC1 PFC1	3/4 1	(3) (3)
Potable Hot Water And Tempered water	Up to 1-1/4 1-1/2 & larger	PMF1 PMF1	1 1.5	(9) (9)
[Process Air	All	PMF1	1	(1)**]**
Refrigerant Suction and Hot Gas Bypass	Up to 1 1 & larger	PFC1 PFC1	1.5 1.5	
[*Insert other*				**]**
PIPING - OUTDOOR (EXPOSED)				
Compressed Air	All	PMF1	1	(1), (4)
Refrigerant Suction and Hot Gas Bypass	Up to 1 1 & larger	PFC1 PFC1	1.5 1.5	(1)
Piping with Heat Tracing	All	PMF1	1.5	(1)
[*Insert other*				**]**
DUCTWORK				
Round	Within conditioned space All other indoor locations	DMF2 DMF2	2 3	(6) (5), (6)
EQUIPMENT				
Expansion Tanks	All	EMF1	1.5	
Mechanical Insulation Types:	FC - Flexible Cellular MF - Mineral Fiber MW - Mineral Wool			

INSULATION SCHEDULE				
		Mechanical Insulation		
Service	Size Inches	Type	Thickness Inches	Notes

Notes:

(1) Aluminum jacket.

(2) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(3) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(4) Insulation shall be provided for exposed portions of the piping system located less than 8 feet above the finished floor or grade.

(5) Insulation shall be provided for outside air plenums and ducts that are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(6) Insulation shall be provided for outside air plenums and ducts, air conditioning supply and return ducts, , unless indicated to be internally lined.

(7) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F .

(8) The underside of all roof drains shall be insulated to a 1 foot radius from the center of the drain. All roof drain piping within 4 feet of the drain shall be insulated.

(9) Includes 8 feet of the cold water inlet piping to the water heater storage tank.

A. Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F or below 60°F shall be insulated.

End of Section

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SECTION 40 61 11 - INSTRUMENTATION AND CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of an instrumentation and control system designated as the Plant Control System for the WWTP and Outfall improvements.

B. The scope of works includes instrumentation and control system as applicable to the below listed process area and emergency engine-generator for power backup.

C. Existing lagoon Upgrade:

i. Add three new floating brush aerators to the 1st Stage Influent Lagoon, with provision of additional three more of the same size and type of aerators in the future.

ii. Add two new floating brush aerators to the 2nd Stage Polishing Lagoon.

D. New Installations:

i. Install an Acid pH adjustment system

ii.Install a chlorination system

iii. Install de-chlorination system

iv. Build a chlorination basin

v. Build a chemical building to house all the chemical dosing systems, electrical and control rooms

E. New Effluent Outfall:

i. Allocate space for a future post-cascade or other type of aeration system

ii. Construct a new outfall structure adjacent to the existing outfall structure

iii. Install a new 24-inch effluent sewer line connecting the chlorination/de- chlorination system with the new outfall structure that can handle the full 4 mgd.

F. Other scope includes works associated with existing Widow's Creek Pump station to supply, erect, install & commission two pumps along with pipe work, valves, AFDs and instrumentation & control. Also flow measurement of effluent flow to Bridgeport WWTP chlorine contact basin.

G. The System supplier shall be responsible for the following scope of work associated with WWTP & Outfall Improvements project.

1. Provide PLC programming and configuration for I/O's as shown on the I/O list.

2. The systems shall be furnished as specified, complete with all software, human machine (HMI) hardware, operator Interface Terminals (OITs), input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

3. Equipment and software furnished under this section and under other related sections listed in the scope paragraphs shall be designed, coordinated and supplied by a single manufacturer or supplier, herein after referred to as the system supplier.

4. System supplier shall provide instruments as shown on the P&ID drawings and listed on the instrument device schedule. System supplier shall be responsible for instrument installation and calibration of those instruments which shall be outside the scope of equipment vendors.

5. A new WWTP PLC (PLC-4000) shall be furnished and installed by the system supplier in the WWTP chemical building and integrate it into the PCS network. Necessary graphics/database shall be developed by the system supplier.

6. System supplier shall also be responsible for furnishing and installing new Master radio (COMM-4000) within the WWTP chemical building in local control panel (LCP-4000). System supplier shall also be responsible to integrate radio into the PCS system.

7. System supplier shall also be responsible for integrating existing pump station system through fiber optic line with PLC-4000 by furnishing and installing new fiber patch panel and network switch, cables & accessories as necessary.

8. The System Supplier shall be responsible for integrating the new equipment at the existing Widow's Creek Pump Station, including two (2) pumps, associated valves, adjustable frequency drives (AFDs), effluent flow measurement to the Bridgeport WWTP chlorine contact basin, and all related instrumentation and control systems, as indicated on the P&IDs. This integration shall be completed within the Bridgeport WTP SCADA/PCS system.

9. System Supplier shall be responsible for integrating engine generator I/O's into PLC-4000, System supplier shall provide all necessary PLC programming, communications, HMI graphics, data configuration, alarms, and related accessories required for complete integration into the PCS system.

10. System supplier shall provide spare parts as specified. System supplier shall also be responsible to provide field services as necessary to provide installation, supervision, startup and training.

H. The system shall be furnished as specified, complete with all software, Plant Control System (PCS) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

I. Associated Sections

1. This section also includes the equipment and services specified in the following sections.

Section 40 64 00	PROGRAMMABLE LOGIC CONTROLLERS
Section 40 66 11	PROCESS CONTROL NETWORK SYSTEMS
Section 40 66 33	METALLIC COMMUNICATION CABLE AND CONNECTORS
Section 40 66 34	FIBER OPTIC COMMUNICATION CABLE AND EQUIPMENT
Section 40 66 53	RADIO EQUIPMENT
Section 40 67 11	PANELS, CONSOLES, AND APPURTENANCES
Section 40 68 83	SOFTWARE CONTROL BLOCK DESCRIPTIONS
Section 40 71 00	FLOW INSTRUMENTS
Section 40 71 23.11	FLOW TUBES AND VENTURI TUBES
Section 40 72 00	PRESSURE AND LEVEL INSTRUMENTS
Section 40 73 00	PRESSURE INSTRUMENTS
Section 40 73 12	PRESSURE GAUGES
Section 40 74 00	TEMPERATURE INSTRUMENTS
Section 40 75 00	PROCESS ANALYTICAL INSTRUMENTS
Section 40 79 11	MISCELLANEOUS INSTRUMENTS

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are attached as an appendix to the Programmable Logic Controllers section and are indicated on the Drawings.

2. Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and Instrument Device Schedule attached to this section.

D. Codes, Permits and Agency Approvals

1. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories or another Occupational Safety and Health Administration (OSHA) National Recognized Testing Laboratory. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

E. Supplier’s Qualifications

1. Equipment and software furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System Supplier shall be regularly engaged in the business of supplying computer-based monitoring, control, and data acquisition systems. The Contractor shall utilize the services of the System Supplier to coordinate all control system related items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

2. The System Supplier shall have the following minimum qualifications:

   a. The supplier shall maintain a design office staffed with qualified technical design personnel.
   b. The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
   c. The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

F. Coordination

1. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed

in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

G. Related Equipment and Materials

1. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

H. Device Tag Numbering System

1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1.3 GENERAL REQUIREMENTS

A. The Drawings and Specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

B. The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

C. Governing Standards

1. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

E. Workmanship and Materials

1. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

F. Corrosive Fluids

1. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

G. Appurtenances

1. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

H. Programming Devices

1. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup.

1.4 SUBMITTALS

A. General

1. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete.

Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

B. First Stage Submittal

1. The first stage submittal shall include the following items.

a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.

b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.

c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.

d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

f. Environmental and power requirements, including heat release information for each equipment item.

g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

h. A copy of the proposed software licenses for all software associated with the system.

i, Outline for training classes.

j. Additional requirements identified in other Division 40 sections.

C. Second Stage Submittal

1. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

2. At System Supplier’s option, the first and second stage submittals may be combined.

a. Detailed functional descriptions of all software modules specified and furnished as part of System Supplier’s standard system. The descriptions shall be identified with the applicable specification paragraph.

b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and

control devices.

c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.

d. Fiber termination diagrams to show all fiber terminations at fiber patch panels and final termination at equipment. Fiber termination diagrams shall show individual fiber type (single or multimode), fiber core/cladding dimensions, fiber colors, circuit identifications, and type of terminator.

e. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

f. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

g. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

h. Standard system engineering and user manuals describing the use of the system and application programming techniques for creating reports, graphics, database, historical records, and adding new process I/O nodes to the system.

i. Additional Requirements identified in other Division 40 sections.

D. Third Stage Submittal

1. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other Division 40 specification sections.

1.5 PREPARATION FOR SHIPMENT

A. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or

otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

D. Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

E. Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

F. Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1.6 DELIVERY, STORAGE, AND SHIPPING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.7 SPARE PARTS

A. In addition to spare parts and consumable items specified in other sections, the following spares and consumable items shall be provided:

Spare Parts	Quantity
Lamps for indicating lights	1 full set
Input-Output module	1 each type

B. Packaging

1. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

C. Replacement

1. System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

B. Standard Products

1. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

2. To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

B. Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

C. Factory Assembly

1. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.

D. Expandability

1. The system shall be capable of expansion as follows:

Future Requirement	Quantity
PLC	50% in addition to specified here
I/O points	50% in addition to specified here
Operator workstations	50% in addition to specified here
Communication channels	50% in addition to specified here

2.3 POWER SUPPLY AND INSTRUMENT SIGNAL

A. Power supply to all control system equipment will be 120 volts ac. System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.

B. Unless otherwise indicated, power supply to the instrumentation will be unregulated 120 volts ac. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

C. Facility Distribution System

1. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ±10 percent and harmonics up to the limits of IEEE 519 without affecting operation. System Supplier shall provide voltage conditioning or filtering equipment if necessary to meet the requirements specified.

D. Power Supplies

1. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected.

E. Surge Withstand

1. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

F. Uninterruptible Power Supply

1. An uninterruptible power supply (UPS) shall be furnished hereunder to power the equipment indicated on the Drawings or will be furnished under another section. System Supplier shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder and shall advise Engineer if a unit of higher capacity is necessary.

2.4 SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS

A. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

B. All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

C. Ambient Temperature and Elevation

1. All system equipment located in air conditioned rooms shall be suitable for operation in ambient temperatures from 10° C to 35° C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non air conditioned indoor areas shall be suitable for an ambient temperature range of 0° C to 50° C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20° C to 60° C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

2. All equipment and instruments shall be designed to operate at the site elevation of 630ft.

D. Deleterious Effects

1. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

2. All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

E. Noise Level

1. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

F. Lightning Protection

1. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2. Grounding

   a. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

3. Surge Suppressors

   a. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) type, silicon junction type, Gas Discharge Tube (GDT) type, or some combination of these types, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:
      1) All 120 volts ac power connections to RTUs, PLCs, DCUs, instruments and control room equipment. Surge arresters shall be Transtector "SPD 12R Series", Phoenix Contact “PLT-SEC Series”, MCG Surge Protection “400 Series” or equal.
      2) All connections to coaxial-based networked equipment (including CCTV, CATV, Ethernet, and satellite) where any part of the circuit is outside of the building envelope. Surge arresters shall be Transtector CCTV-PTZ Series”, Phoenix Contact “CoaxTrab Series”, or equal.
      3) All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication.
         a) Protection devices located at the field transmitter shall be:
            - Loop Powered Transmitters – Eaton MTL “TP48”, Phoenix Contact “Surge Trab Series”, Transtector “PDS Outdoor Series” or equal.
            - Four-Wire Transmitters – Phoenix Contact “BoxTrab Series”, Schneider Electric ASCO Model 265, Emerson “SolarHD STC-SLAC Series”, or equal.
         b) Protection devices in control panels shall be Transtector “12R IEP Series”, Eaton MTL “SD Modular Series”, Phoenix Contact “TTC-6P Series”, or equal.

4) All metallic pair (twisted and untwisted) conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope. Single-port protective devices shall be Phoenix Contact “DataTrab Series”, Transtector “FSP” Series”, Citel “MJ8 Series”, Eaton MTL “NP Series”, or equal.
5) All serial, PLC data highway, and remote I/O network termination points where any part of the circuit is routed outside of the building envelope. Surge protection devices shall be Transtector “DRDC Series” (RS-232); Transtector “FSP Series” (RS-422), Phoenix Contact “TTC-6P Series”, Citel “E280 Series”, or equal.
6) All radio antenna leads. Surge protection devices shall be as specified in Radio Equipment section.
7) All telephone lines at points of connection to the system. Protection devices for telecommunication circuits shall be Phoenix Contact “DataTrab Series”, Transtector “TSJ or LMP Series”, Telebyte “Model 22PX”, Citel “MJ8”, or equal.

2.5 SOFTWARE DOCUMENTATION

A. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

1. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.

2. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.

3. Three sets of user reference manuals for all standard system and application software.

4. One set of user reference manuals for all operating system software.

5. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.

6. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2.6 SOFTWARE LICENSE

A. All software programs supplied as a standard part of System Supplier’s products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict

Owner from using the software on the system provided hereunder or its replacement. Specific requirements of System Supplier's software license are subject to review and approval by Owner and Engineer.

2.7 INSTALLATION TEST EQUIPMENT

A. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier. System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

2.8 PROGRAMMING DEVICES

A. An instrument programming device shall be provided for the instruments specified in other sections. Quantity of programming devices shall be as specified in other sections.

2.9 PROGRAMMING SOFTWARE

A. Instrument programming software shall be provided for the instruments specified in other sections. Specified software license shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

B. Field Wiring

1. Field wiring materials and installation shall be in accordance with the electrical section.

C. Instrument Installation

1. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

2. All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

D. Salvage of Existing Equipment

1. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

2. Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3.2 SYSTEM SOFTWARE CONFIGURATION

A. System software shall be configured by the System Supplier. Configuration services shall consist of the creation of the system database, report formats, operator interface graphic and tabular display screen formats, password and security implementation, and programming of control units to provide a fully functioning system. The System Supplier shall fully configure the system using data provided herein or supplied by the Engineer and/or the Owner after award of the contract.

B. The system that is delivered to the field for installation, checkout, and startup shall have all files, or databases, that are configurable in size, sized so that there will be 50% space available for future work after the completion of this project. This sizing should include the addition of memory modules, disk drives, or any other device to insure the 50% spare space availability. All "tuning" of software that is dependent on space requirements shall be done prior to the completion of this project.

C. Tuning of software programs shall be accomplished in such a manner that the program operates at its highest performance level. These programs include, but are not limited to Microsoft SQL Server, all PLC ladder logic, and others.

D. Control System Database

1. The control system database shall be developed and configured by the System Supplier. The System Supplier shall enter information obtainable from the Contract Documents into the database prior to soliciting input from the Engineer and the Owner. The System Supplier shall determine the need for any "pseudo" database points and shall ascertain and enter all information needed to define these points. The System Supplier is responsible for entering all information associated with each point. This includes but is not limited to, descriptions, engineering units, associated displays, areas, security, etc. All fields associated with each database point must be completely filled out accurately.

E. Graphic Screen Displays

1. The System Supplier shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored by the control system shall be displayed on one or more graphic screen. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all

devices and equipment that is part of the control loops. These items must be done in accordance to the Configuration Standards and Conventions as described later in this section. Alarm and/or event displays shall also be provided and proven functional prior to acceptance of the system. A means of capturing and printing of all graphic screens shall also be included. The software program provided must be capable of printing the screen in a black and white (using gray scale) or color format. This program must be accessible from all terminals provided under this contract. The black and white printing shall be done in a manner in which the use of the black background is not represented in the printout. This is done to keep the utilization of ink cartridge and toner cartridge to a minimum.

2. All graphic screens shall be animated to indicate the current state of the piece of equipment. The following graphic screens shall be provided, as a minimum.

    a. Main Overview of Plant
    b. Alarm Summary
    c. Event Summary
    d. Overview of each major process area (with vectoring to sub-areas)
    e. Summary screen to vector to all video trends

3. A minimum of 10 custom graphic displays shall be provided by the System Supplier.

F. Report Formats

1. Report formats shall be developed and programmed by the System Supplier using tag names defined in the database creation. Reports shall be provided as summarized below. All reports will be provided with a header on each page to indicate the contents of each column of information. Each page shall be numbered and indicate the name of the report, the date the report was printed, and the time of the printout. The printout shall also include the time span of the information shown on the report.

    a. Daily Operating Report. A daily report, listing the major plant variables (up to 12 variables) shall be provided. The report shall include hourly values and minimum/maximum/average values where appropriate. A minimum of four separate daily reports shall be provided by the System Supplier.
    b. Monthly Operating Report. A monthly operating report, which averages the values from the above daily reports, shall be provided. The report shall include monthly minimum/maximum/average values where appropriate.

G. Configuration Standards and Conventions

1. A “Software Configuration Standards and Conventions” document shall be prepared and submitted by the System Supplier. The document shall be submitted for review and approval before software configuration commences. The document shall describe and define such items as proposed graphic display process line colors/representations; symbiology; color standards for “on”, “off”, “opened”, “closed”, and “alarm” conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Before submitting the initial draft document, the System Supplier shall meet with the

Engineer and/or Owner to review any of the Owner's existing standards and conventions. All copies of this submittal shall be provided in color to insure the accuracy of each item. No black and white copies will be accepted. The colors used in the printed submittal shall accurately depict the colors and shapes proposed for use on the final system.

2. In addition to submitting the document for review, an updated version of the document shall be submitted as part of the O&M Manuals. The document shall be revised to document any additional standards that are established throughout the configuration process.

H. Configuration Review Meetings

1. Proposed graphic screens and report formats shall be reviewed with the Owner and Engineer throughout the configuration process. The System Supplier's programming personnel shall attend all meetings. The first review meeting shall be held within two months of the notice to proceed as indicated in the Configuration Standards and Convention section above. A second review meeting shall be held at approximately 50 percent completion. Both meetings shall be held at the Owner's facilities.

I. Software Functional Requirements

1. General functional requirements for system configuration are indicated on the Drawings and described in the specifications. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system. The System Supplier shall be responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Engineer or the Owner.

3.3 SYSTEMS CHECK

A. System Supplier shall provide the services of a field manager and a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

B. Field Manager

1. System Supplier shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

C. Field Inspection at Delivery

1. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

D. Field Calibration of Instruments

1. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

E. Training for Installation Personnel

1. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment. One day shall be included for this training.

F. Field Inspection Prior to Start Up

1. After installation and wiring connections are complete, the field supervisor, with additional System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. A minimum of five working days shall be included for this task, but System Supplier shall be responsible for completing the following scope of work.

2. Analog Signals

a. Analog input signals shall be simulated at the transmitting source and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

3. Discrete Signals

a. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

4. Devices by Other Suppliers

a. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

5. System Check Out Report

a. The System Supplier shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Engineer or Owner that System Supplier has successfully completed the

external connection check before beginning system startup or field acceptance testing.

G. Start Up Assistance

1. After the field supervisor has completed the system check and submitted the System Check Out Report, System Supplier shall supply a factory-trained engineer and or programmer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. five working days shall be included for this task.

3.4 TESTING

A. The system shall be acceptance tested at the factory and on site.

B. System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and/or Engineer.

C. System Supplier shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. System Supplier shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated factory or site testing necessitated by system failure or inadequate preparation.

D. Factory Acceptance Testing

1. After system assembly and debugging at System Supplier’s facility, the system shall be tested before the system is shipped to the site. The factory test shall be conducted on at least the minimum system consisting of computer hardware, software, printer, and one field I/O device.

2. The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted in the HMI alarm/event log. The testing procedures for hardware and software are described below.

3. All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, HMI display functions, alarm logging, report generation, and historical data storage, as well as the specific functions listed herein. The system shall operate continuously for at least 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by Engineer or Owner.

4. For systems with software configuration by Engineer/Owner, a preliminary version of such configured software may be used as part of the factory acceptance test.

5. Hardware Test

   a. Processors, processor modules, and peripheral devices associated with the system shall be assembled and connected as they will be installed in the field for testing. The test shall demonstrate proper operation of each hardware device and communications among devices and shall include verification of selected analog and discrete inputs and outputs.

6. Software Test

   a. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.

E. Site Acceptance Testing

1. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

2. Site acceptance testing shall be scheduled after receipt of the System Check Out Report and System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.

3. The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of working days of continuous operation for the test shall be thirty. The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

4. Failure of Redundant Equipment

   a. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

5. Completion of Test

a. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3.5 TRAINING

A. System Supplier shall conduct training courses for personnel selected by Owner. Training shall be provided in the categories listed below. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

B. General Training Requirements

1. In general, System Supplier's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training shall be as listed. A "clock hour" is defined as one hour of instruction or supervised training exercise. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

2. Training Costs

   a. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Engineers personnel to attend off-site training programs; shall be the responsibility of System Supplier and shall be included in the contract price.

3. Lessons

   a. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.

4. Video Recording

   a. All training sessions shall be video recorded by the System Supplier for Owner's future use in training other personnel. Video recorded sessions shall be saved to thumb drive for delivery to Owner. Pre-recorded videos of System Supplier's standard training programs may be substituted if they cover the same topics and are developed for the same versions of hardware and software. Furnishing videos of standard training programs shall not relieve System Supplier from any of the training requirements specified herein.

5. Instrument Training

   a. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software. Eight hours of training for four students shall be provided at

the System Supplier's facility. Eight hours of training for six students shall be provided at the Owner's facility.

6. Operator Training

a. Owner's personnel will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

b. Classes
   1) Operator training shall include sessions as specified below.
   2) Pre-installation Session:
      a) Each pre-installation training session shall consist of eight hours of training for four students at the System Supplier's facility eight hours training for six students at the Owner's facility.
   3) Post-installation Session:
      a) The post-installation training shall include three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner's facilities. Each class shall consist of eight hours of instruction using the lesson plan submitted and approved for use. The post-installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner's personnel. The post-installation training sessions shall be conducted for six of the Owner's operating personnel.

c. Content of Classes:
   1) Each session shall cover at least the following topics.
      a) Power-up, "bootstrapping", and shutdown of all hardware devices.
      b) Logging on and off the system and the use of passwords.
      c) Access and interpretation of standard displays and diagnostics.
      d) Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.
      e) Moving from screen to screen within the graphic display environment.
      f) Interpretation of preconfigured group and detailed point or database displays.
      g) Response to and acknowledgment of alarms.
      h) Adjustment of control set points and alarm limits.
      i) Configuration and printing of shift and other reports by schedule or on demand.
      j) Control of field equipment and devices connected to the system.
      k) Manual entries to database points.
      l) Generation of current (real-time) and historical custom and predefined reports and trend displays.

m) Appropriate responses to software and hardware errors.
n) Enabling and disabling individual inputs and outputs.

2) The operator-training program shall be developed for personnel with no prior experience with the hardware and software provided as part of the project.

7. Programmer Training (HMI Software)

a. Programmer training related to Bridgeport WWTP and Outfall improvements on HMI software at Bridgeport WTP shall be co-ordinated by system supplier and furnished as described in this section.

b. System programming training shall be provided to enable Owner's and Engineer's personnel to initially configure and later reconfigure the system. Programming tasks shall include addition or modification to the system database; modification or creation of graphic and tabular display and report formats; and creation and modification of historical archiving groups and data reduction algorithms.

c. Classes

1) Programmer training shall be conducted in two sessions. The first session shall consist of eight hours of instruction for six students and shall be conducted at Owner's or Engineer's facilities within 30 days of delivery of the configuration hardware and software. The second session shall consist of eight hours of instruction for six students and shall be conducted at Owner's facility.

d. Content of Classes

1) Programmer training shall include, but shall not be limited to the following topics:
a) Loading of any supplied software into the system.
b) Use of basic operating system commands for file management, system startup, and creation and editing of batch files.
c) Creation and editing of database.
d) Configuration of printed report formats.
e) Creation and editing of tabular and graphic HMI interface display screens.
f) Diagnostic routines.
g) Creation and modification of control algorithms.
h) Addition of new I/O points and new RTUs, PLCs or DCUs to the system.
i) Historical record retrieval, data reduction, archiving, and disk housekeeping.
j) System backup procedures and reloading from backup.

2) Programmer training shall be designed for personnel who have a general familiarity with control system operation and high-level application programs, but not necessarily with the specific hardware or software furnished for this project.

e. Hardware and Software

1) The first session of training shall be conducted using hardware and software of the same versions as provided for the system specified. Programmer

training for the second session shall be conducted using equipment and software installed at the site.

8. Network Training

   a. System Supplier shall provide training on network equipment provided. Network training shall be conducted in one session at Owner's facilities using the hardware and software installed for this project.
      1) Course shall provide an overall description of the network and how it operates.
      2) A one hour course (for each make/model of switch, router, and firewall) on configuration shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding and shall be provided by the individual that configured the devices. The course shall review the configuration settings. Course training material shall be vendor provided equipment manuals.
      3) A one hour course on the use of the management software shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding and shall be provided by the individual that configured the software. Course training material shall be vendor provided software manuals.
      4) Training shall be provided on the use of any Network Test Equipment provided. Course training material shall be vendor provided equipment manuals.

   b. The training shall provide instruction for up to 5 Owner-selected students.

End of Section

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Black & Veatch	INSTRUMENT CALIBRATION REPORT	□□□Figure 1-406111

Schedule 40 61 11.S01
Instrument Device Schedule

Instrument Device Schedule - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.
Location Code. This is the abbreviation for the associated location. See P&ID Legend & Abbreviation sheets for a list of codes.
System Code. This is the abbreviation for the associated system stream. See P&ID Legend & Abbreviation sheets for a list of codes.
Type. This refers to the instrument type shown on the P&IDs.
Loop. This is the sequential number assigned to the instrument.
Tag. This is the ISA (or similar) alpha tag representing the function of the instrument.
Service Description. This is the description of the instrument service.
Device Type & Size. This is the instrument device type and should match the description as listed in the specification. Where appropriate, the size of the device (such as diameter of flowmeters) will be listed.
Output Type. This generally will be '4-20 mA' or "Dry Contact'. It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface.
Output Range. This is the calibrated range for analog devices or the trip point(s) for discrete devices.
Power Type. This will typically be either '2-wire' for loop powered devices or '4-wire' for 120 volt powered devices.
P&ID Drawing. This is the drawing number of the P&ID where the device is shown.
Specification. This column may include a cross reference to another specification section where applicable or to a note which provides additional information. Notes are appended to the end of the device schedule listings.
Remarks. This column may include additional instrument information such as "shipped loose".

Item	Loca	System	Type	Loop	Tag	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Remarks
1		COLW	LE	1511	COLW-LE-1511	WIDOWS CREEK WETWELL 1 LEVEL	DIFFERENTIAL PRESSURE TYPE LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-15-601	40 72 00	
2		COLW	LIT	1511	COLW-LIT-1511	WIDOWS CREEK WETWELL 1 LEVEL	DIFFERENTIAL PRESSURE TYPE LEVEL TRANSMITTER	N/A	4-20 mA DC	0-11 FT	2-WIRE	I-15-601	40 72 00	
3		COLW	LSH	1511	COLW-LSH-1511	WIDOWS CREEK WETWELL 1 HIGH LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	
4		COLW	LSL	1511	COLW-LSL-1511	WIDOWS CREEK WETWELL 1 LOW LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	
5		COLW	LE	1521	COLW-LE-1521	WIDOWS CREEK WETWELL 2 LEVEL	DIFFERENTIAL PRESSURE TYPE LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-15-601	40 72 00	
6		COLW	LIT	1521	COLW-LIT-1521	WIDOWS CREEK WETWELL 2 LEVEL	DIFFERENTIAL PRESSURE TYPE LEVEL TRANSMITTER	N/A	4-20 mA DC	0-11 FT	2-WIRE	I-15-601	40 72 00	
7		COLW	LSH	1521	COLW-LSH-1521	WIDOWS CREEK WETWELL 2 HIGH LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	
8		COLW	LSL	1521	COLW-LSL-1521	WIDOWS CREEK WETWELL 2 LOW LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	
9		COLW	TSH	1511	COLW-TSH-1511	WIDOWS CREEK WETWELL 1 PUMP MOTOR HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	43 24 13	
10		COLW	HS	1511	COLW-HS-1511	WIDOWS CREEK WETWELL 1 PUMP EMERGENCY STOP	EMERGENCY STOP PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-15-601	26 05 11	
11		COLW	PG	1511	COLW-PG-1511	WIDOWS CREEK WETWELL 1 PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-110 PSI	N/A	I-15-601	40 73 12	WITH DIAPHRAGM SEAL
12		COLW	PSH	1511	COLW-PSH-1511	WIDOWS CREEK WETWELL 1 PUMP DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	WITH DIAPHRAGM SEAL
13		COLW	TSH	1521	COLW-TSH-1521	WIDOWS CREEK WETWELL 2 PUMP MOTOR HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	43 24 13	
14		COLW	HS	1521	COLW-HS-1521	WIDOWS CREEK WETWELL 2 PUMP EMERGENCY STOP	EMERGENCY STOP PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-15-601	26 05 11	
15		COLW	PG	1521	COLW-PG-1521	WIDOWS CREEK WETWELL 2 PUMP DISCHARGE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-110 PSI	N/A	I-15-601	40 73 12	WITH DIAPHRAGM SEAL
16		COLW	PSH	1521	COLW-PSH-1521	WIDOWS CREEK WETWELL 2 PUMP DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-15-601	40 72 00	WITH DIAPHRAGM SEAL
17		COLW	FE	1500	COLW-FE-1500	WIDOWS CREEK PUMPS HEADER TO BRIDGEPORT WWTP CHLORINE CONTACT BASIN FLOW	MAGNETIC FLOW SIGNAL CONVERTER SENSOR	12"	PER MFR	SEE FIT	N/A	I-15-601	40 71 00	
18		COLW	FIT	1500	COLW-FIT-1500	WIDOWS CREEK PUMPS HEADER TO BRIDGEPORT WWTP CHLORINE CONTACT BASIN FLOW	MAGNETIC FLOW SIGNAL CONVERTER TRANSMITTER	N/A	4-20 mA DC	0-8,000 GPM	4-WIRE	I-15-601	40 71 00	
19		COLW	PG	1550	COLW-PG-1550	WIDOWS CREEK PS HEATING SYSTEM TANK PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-200 PSI	N/A	I-15-601	43 42 41.10	
20		COLW	TE	1550	COLW-TE-1550	WIDOWS CREEK PS HEATING SYSTEM TANK TEMPERATURE	TEMPERATURE ELEMENT	N/A	N/A	0-50 °F	N/A	I-15-601	43 42 41.10	
21		TE	AE	3001	TE-AE-3001	CHLORINE CONTACT BASIN INLET CHLORINE	CHLORINE ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
22		TE	AIT	3001	TE-AIT-3001	CHLORINE CONTACT BASIN INLET CHLORINE	CHLORINE ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-4 mg/L	4-WIRE	I-30-601	40 75 00	
23		TE	LE	3001	TE-LE-3001	CHLORINE CONTACT BASIN LEVEL	ULTRASONIC LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-30-601	40 72 00	
24		TE	LIT	3001	TE-LIT-3001	CHLORINE CONTACT BASIN LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	4-20 mA DC	0-15 FT	4-WIRE	I-30-601	40 72 00	
25		TE	AE	3002	TE-AE-3002	CHLORINE CONTACT BASIN PARSHALL FLUME CHLORINE	CHLORINE ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
26		TE	AIT	3002	TE-AIT-3002	CHLORINE CONTACT BASIN PARSHALL FLUME CHLORINE	CHLORINE ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-1 mg/L	N/A	I-30-601	40 75 00	
27		TE	FE	3002	TE-FE-3002	CHLORINE CONTACT BASIN PARSHALL FLUME FLOW	OPEN CHANNEL ULTRASONIC FLOW SENSOR	N/A	PER MFR	SEE LIT	N/A	I-30-601	40 72 00	
28		TE	FIT	3002	TE-FIT-3002	CHLORINE CONTACT BASIN PARSHALL FLUME FLOW	OPEN CHANNEL ULTRASONIC FLOW TRANSMITTER	N/A	4-20 mA DC	0-4 MGD	2-WIRE	I-30-601	40 72 00	
29		TE	AE	3003	TE-AE-3003	CHLORINE CONTACT BASIN PARSHALL FLUME pH	pH ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
30		TE	AIT	3003	TE-AIT-3003	CHLORINE CONTACT BASIN PARSHALL FLUME pH	pH ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-9 S.U.	4-WIRE	I-30-601	40 75 00	
31		TE	AE	3004	TE-AE-3004	CHLORINE CONTACT BASIN OUTLET CHLORINE	CHLORINE ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
32		TE	AIT	3004	TE-AIT-3004	CHLORINE CONTACT BASIN OUTLET CHLORINE	CHLORINE ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-2 mg/L	4-WIRE	I-30-601	40 75 00	
33		TE	AE	3005	TE-AE-3005	CHLORINE CONTACT BASIN PARSHALL FLUME DISSOLVED OXYGEN	DO ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
34		TE	AIT	3005	TE-AIT-3005	CHLORINE CONTACT BASIN PARSHALL FLUME DISSOLVED OXYGEN	DO ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-10 mg/L	4-WIRE	I-30-601	40 75 00	
35		COLW	AE	3006	COLW-AE-3006	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE pH	pH ANALYZER SENSOR	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
36		COLW	AIT	3006	COLW-AIT-3006	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE pH	pH ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-12	4-WIRE	I-30-601	40 75 00	
37		COLW	TE	3006	COLW-TE-3006	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE TEMPERATU	TEMPERATURE SENSOR	N/A	PER MFR	SEE TIT	N/A	I-30-601	40 74 00	
38		COLW	TIT	3006	COLW-TIT-3006	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE TEMPERATU	TEMPERATURE TRANSMITTER	N/A	4-20 mA DC	0-100° F	4-WIRE	I-30-601	40 74 00	
39		COLW	AE	3007	COLW-AE-3007	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE ALK	ALK ANALYZER TRANSMITTER	N/A	PER MFR	SEE AIT	N/A	I-30-601	40 75 00	
40		COLW	AIT	3007	COLW-AIT-3007	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE ALK	ALK ANALYZER TRANSMITTER	N/A	4-20 mA DC	0-1,000 mg/L	4-WIRE	I-30-601	40 75 00	
41		COLW	PG	3001	COLW-PG-3001	WIDOWS CREEK PUMP STATION TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-120 PSI	N/A	I-30-601	40 72 00/ 40 73 12	
42		COLW	FG	3001	COLW-FG-3001	SULFURIC ACID TO COOLING WATER VALVE AND INSTRUMENTATION STATION LINE FLOW	ROTAMETER	1"	PER MFR	0-5 gpm	N/A	I-30-601	40 71 00	
43		TE	LE	3000	TE-LE-3000	CHLORINE CONTACT BASIN JUNCTION STRUCTURE LEVEL	ULTRASONIC LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-30-601	40 72 00	
44		TE	LIT	3000	TE-LIT-3000	CHLORINE CONTACT BASIN JUNCTION STRUCTURE LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	4-20 mA DC	0-15 FT	4-WIRE	I-30-601	40 72 00	
45		HSO4	WE	4001	HSO4-WE-4001	SULFURIC ACID STORAGE TOTE WEIGHT 1	WEIGHT SCALE SENSOR	N/A	PER MFR	SEE WIT	N/A	I-40-601	46 33 00	
46		HSO4	WIT	4001	HSO4-WIT-4001	SULFURIC ACID STORAGE TOTE WEIGHT 1	WEIGHT SCALE TRANSMITTER	N/A	4-20 mA DC	0-8,500 LBS	2-WIRE	I-40-601	46 33 00	
47		HSO4	WE	4002	HSO4-WE-4002	SULFURIC ACID STORAGE TOTE WEIGHT 2	WEIGHT SCALE SENSOR	N/A	PER MFR	SEE WIT	N/A	I-40-601	46 33 00	
48		HSO4	WIT	4002	HSO4-WIT-4002	SULFURIC ACID STORAGE TOTE WEIGHT 2	WEIGHT SCALE TRANSMITTER	N/A	4-20 mA DC	0-8,500 LBS	2-WIRE	I-40-601	46 33 00	
49		HSO4	PG	4011	HSO4-PG-4011	SULFURIC ACID METERING PUMP NO. 1 DISCHARGE PULSATION DAMPENER PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-70 PSI	N/A	I-40-601	46 33 00	
50		HSO4	PSH	4011	HSO4-PSH-4011	SULFURIC ACID METERING PUMP NO. 1 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-601	40 72 00	
51		HSO4	PG	4012	HSO4-PG-4012	SULFURIC ACID METERING PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-100 PSI	N/A	I-40-601	46 33 00	
52		HSO4	PG	4021	HSO4-PG-4021	SULFURIC ACID METERING PUMP NO. 2 DISCHARGE PULSATION DAMPENER PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-70 PSI	N/A	I-40-601	46 33 00	
53		HSO4	PSH	4021	HSO4-PSH-4021	SULFURIC ACID METERING PUMP NO. 2 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-601	40 72 00	
54		HSO4	PG	4022	HSO4-PG-4022	SULFURIC ACID METERING PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-100 PSI	N/A	I-40-601	46 33 00	
55		HSO4	FAX	4000	HSO4-FAX-4000	SULFURIC ACID STORAGE AREA EMERGENCY EYEWASH ACTIVATED ALARM	ALARM HORN	N/A	N/A	N/A	120 VAC	I-40-601	46 33 00	
56		HSO4	FSH	4000	HSO4-FSH-4000	SULFURIC ACID STORAGE AREA EMERGENCY EYEWASH ACTIVATED	FLOW SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-601	22 00 00	
57		HSO4	PG	4001	HSO4-PG-4001	SERVICE WATER TO SULFURIC ACID DILUTION PANEL PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-100 PSI	N/A	I-40-601	40 72 00/ 40 73 12	
58		HSO4	FSL	4001	HSO4-FSL-4001	SERVICE WATER TO SULFURIC ACID DILUTION PANEL LOW FLOW	FLOW SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-601	22 00 00	
59		HSO4	FG	4001	HSO4-FG-4001	SERVICE WATER TO SULFURIC ACID DILUTION PANEL FLOW INDICATOR	ROTAMETER	1"	PER MFR	0-5gpm	N/A	I-40-601	40 71 00	
60		HSO4	TG	4001	HSO4-TG-4001	SULFURIC ACID DILUTION PANEL TO CHLORINE CONTACT BASIN LINE TEMPERATURE	TEMPERATURE GAUGE	4 1/2" DIAL	N/A	30-200°F	N/A	I-40-601	40 74 00	
61		HSO4	TSH	4001	HSO4-TSH-4001	SULFURIC ACID DILUTION PANEL TO CHLORINE CONTACT BASIN LINE HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-601	40 74 00	
62		NOCL	FAX	4100	NOCL-FAX-4100	SODIUM HYPOCHLORITE STORAGE AREA EMERGENCY EYEWASH 1 ACTIVATED ALARM	ALARM HORN	N/A	N/A	N/A	120 VAC	I-40-603	22 00 00	
63		NOCL	FSH	4100	NOCL-FSH-4100	SODIUM HYPOCHLORITE STORAGE AREA EMERGENCY EYEWASH 1 ACTIVATED	FLOW SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-603	22 00 00	
64		NOCL	HMS	4100	NOCL-HMS-4100	SODIUM HYPOCHLORITE STORAGE TANKS ALARM SILENCE	PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-40-603	26 05 11	
65		NOCL	LAH	4100	NOCL-LAH-4100	SODIUM HYPOCHLORITE STORAGE TANKS CONTAINMENT HIGH LEVEL ALARM INDICATION	INDICATING LIGHT	N/A	N/A	N/A	N/A	I-40-603	46 33 00	
66		NOCL	LAX	4100	NOCL-LAX-4100	SODIUM HYPOCHLORITE STORAGE TANKS ALARM	ALARM HORN	N/A	N/A	N/A	N/A	I-40-603	46 33 00	
67		NOCL	LSH	4100	NOCL-LSH-4100	SODIUM HYPOCHLORITE STORAGE AREA CONTAINMENT HIGH LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-603	40 72 00	
68		NOCL	LAH	4101	NOCL-LAH-4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 HIGH LEVEL ALARM INDICATION	INDICATING LIGHT	N/A	N/A	N/A	N/A	I-40-603	46 33 00	
69		NOCL	LG	4101	NOCL-LG-4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 LEVEL	SIGHT GAUGE LEVEL	N/A	N/A	0-12 FT	N/A	I-40-603	43 41 45.13	
70		NOCL	LI	4101	NOCL-LI-4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 LEVEL INDICATION	LEVEL INDICATOR	N/A	4-20 mA DC	0-12 FT	2-WIRE	I-40-603	40 72 00	
71		NOCL	LE	4101	NOCL-LE-4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 LEVEL	ULTRASONIC LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-40-603	40 72 00	
72		NOCL	LIT	4101	NOCL-LIT-4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 LEVEL	ULTRASONIC LEVEL TRANSMITTER	N/A	4-20 mA DC	0-12 FT	4-WIRE	I-40-603	40 72 00	
73		NOCL	FAX	4101	NOCL-FAX-4101	SODIUM HYPOCHLORITE STORAGE AREA EMERGENCY EYEWASH 2 ACTIVATED ALARM	ALARM HORN	N/A	N/A	N/A	120 VAC	I-40-603	22 00 00	
74		NOCL	FSH	4101	NOCL-FSH-4101	SODIUM HYPOCHLORITE STORAGE AREA EMERGENCY EYEWASH 2 ACTIVATED	FLOW SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-603	22 00 00	
75		NOCL	PG	4111	NOCL-PG-4111	SODIUM HYPOCHLORITE METERING PUMP NO. 1 SUCTION PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-9.5 PSI	N/A	I-40-604	46 33 00	
76		NOCL	PSH	4111	NOCL-PSH-4111	SODIUM HYPOCHLORITE METERING PUMP NO. 1 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-604	40 72 00	
77		NOCL	PG	4112	NOCL-PG-4112	SODIUM HYPOCHLORITE METERING PUMP NO. 1 DISCHARGE PULSATION DAMPENER PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-604	46 33 00	
78		NOCL	PG	4113	NOCL-PG-4113	SODIUM HYPOCHLORITE METERING PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-604	46 33 00	
79		NOCL	PG	4121	NOCL-PG-4121	SODIUM HYPOCHLORITE METERING PUMP NO. 2 SUCTION PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-9.5 PSI	N/A	I-40-604	46 33 00	
80		NOCL	PSH	4121	NOCL-PSH-4121	SODIUM HYPOCHLORITE METERING PUMP NO. 2 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-604	40 72 00	
81		NOCL	PG	4122	NOCL-PG-4122	SODIUM HYPOCHLORITE METERING PUMP NO. 2 DISCHARGE PULSATION DAMPENER PRESSURE	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-604	46 33 00	
82		NOCL	PG	4123	NOCL-PG-4123	SODIUM HYPOCHLORITE METERING PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-55 PSI	N/A	I-40-604	46 33 00	
83		NHS	FAX	4200	NHS-FAX-4200	SODIUM BISULFITE STORAGE AREA EMERGENCY EYEWASH ACTIVATED ALARM	ALARM HORN	N/A	N/A	N/A	120 VAC	I-40-605	46 33 00	
84		NHS	FSH	4200	NHS-FSH-4200	SODIUM BISULFITE STORAGE AREA EMERGENCY EYEWASH ACTIVATED	FLOW SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-605	22 00 00	

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Instrument Device Schedule

Item	Loca	System	Type	Loop	Tag	Service Description	Device Type	Size	Output Type	Output Range	Power Type	P&ID Drawing	Specification	Remarks
85		NHS	LAH	4200	NHS-LAH-4200	SODIUM BISULFITE STORAGE TANK CONTAINMENT HIGH LEVEL ALARM INDICATION	INDICATING LIGHT	N/A	N/A	N/A	N/A	I-40-605	46 33 00	
86		NHS	LSH	4200	NHS-LSH-4200	SODIUM BISULFITE STORAGE AREA CONTAINMENT HIGH LEVEL	FLOAT TYPE LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-605	40 72 00	
87		NHS	HMS	4201	NHS-HMS-4201	SODIUM BISULFITE STORAGE TANK HIGH LEVEL ALARM SILENCE	PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-40-605	26 05 11	
88		NHS	LAH	4201	NHS-LAH-4201	SODIUM BISULFITE STORAGE TANK HIGH LEVEL ALARM INDICATION	INDICATING LIGHT	N/A	N/A	N/A	N/A	I-40-605	46 33 00	
89		NHS	LAX	4201	NHS-LAX-4201	SODIUM BISULFITE STORAGE TANK HIGH LEVEL ALARM	ALARM HORN	N/A	N/A	N/A	N/A	I-40-605	46 33 00	
90		NHS	LG	4201	NHS-LG-4201	SODIUM BISULFITE STORAGE TANK LEVEL	SIGHT GAUGE LEVEL	N/A	N/A	0-11.5 FT	N/A	I-40-605	43 41 45.13	
91		NHS	LI	4201	NHS-LI-4201	SODIUM BISULFITE STORAGE TANK LEVEL INDICATION	LEVEL INDICATOR	N/A	4-20 mA DC	0-11.5 FT	2-WIRE	I-40-605	40 72 00	
92		NHS	LE	4201	NHS-LE-4201	SODIUM BISULFITE STORAGE TANK LEVEL	ULTRASONIC LEVEL SENSOR	N/A	PER MFR	SEE LIT	N/A	I-40-605	40 72 00	
93		NHS	LIT	4201	NHS-LIT-4201	SODIUM BISULFITE STORAGE TANK LEVEL	ULTRASONIC TYPE LEVEL TRANSMITTER	N/A	4-20 mA DC	0-11.5 FT	4-WIRE	I-40-605	40 72 00	
94		NHS	PG	4211	NHS-PG-4211	SODIUM BISULFITE METERING PUMP NO. 1 DISCHARGE PULSATION DAMPENER PRESSURE 1	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-606	46 33 00	
95		NHS	PSH	4211	NHS-PSH-4211	SODIUM BISULFITE METERING PUMP NO. 1 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-606	40 72 00	
96		NHS	PG	4212	NHS-PG-4212	SODIUM BISULFITE METERING PUMP NO. 1 DISCHARGE PRESSURE 2	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-606	46 33 00	
97		NHS	PG	4221	NHS-PG-4221	SODIUM BISULFITE METERING PUMP NO. 2 DISCHARGE PULSATION DAMPENER PRESSURE 1	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-606	46 33 00	
98		NHS	PSH	4221	NHS-PSH-4221	SODIUM BISULFITE METERING PUMP NO. 2 DISCHARGE HIGH PRESSURE	PRESSURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-40-606	40 72 00	
99		NHS	PG	4222	NHS-PG-4222	SODIUM BISULFITE METERING PUMP NO. 2 DISCHARGE PRESSURE 2	PRESSURE GAUGE	4 1/2" DIAL	N/A	0-55 PSI	N/A	I-40-606	46 33 00	
100		FUE	AAX	5001	FUE-AAX-5001	ENGINE GENERATOR GEN-5000 FUEL TANK 90% CAPACITY ALARM	ALARM HORN	N/A	N/A	N/A	N/A	I-50-601	26 05 11	
101		FUE	HMS	5001	FUE-HMS-5001	ENGINE GENERATOR GEN-5000 FUEL TANK 90% CAPACITY ALARM SILENCE	PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 05 11	
102		FUE	HS	5001	FUE-HS-5001	ENGINE GENERATOR GEN-5000 REMOTE EMERGENCY SHUTDOWN SWITCH ACTIVATED	EMER. PUSHBUTTON	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 05 11	
103		FUE	LIT	5001	FUE-LIT-5001	ENGINE GENERATOR GEN-5000 FUEL TANK LEVEL	LEVEL TRANSMITTER	N/A	4-20 mA DC	PER MFR	PER SUPPLIER	I-50-601	26 32 13	RANGE PROVIDED BY ENGINE-GENERATOR MANUFACTURER
104		FUE	LSH	5001	FUE-LSH-5001	ENGINE GENERATOR GEN-5000 FUEL TANK HIGH LEVEL	LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER
105		FUE	LSHH	5001	FUE-LSHH-5001	ENGINE GENERATOR GEN-5000 FUEL TANK HIGH HIGH LEVEL	LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER
106		FUE	LSL	5001	FUE-LSL-5001	ENGINE GENERATOR GEN-5000 FUEL TANK LOW LEVEL	LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER
107		FUE	TSH	5001	FUE-TSH-5001	ENGINE GENERATOR GEN-5000 FUEL TANK HIGH TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER
108		FUE	TSL	5001	FUE-TSL-5001	ENGINE GENERATOR GEN-5000 FUEL TANK LOW TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER
109		FUE	LSH	5002	FUE-LSH-5002	ENGINE GENERATOR GEN-5000 FUEL TANK SECONDARY CONTAINMENT TANK HIGH LEVEL	LEVEL SWITCH	N/A	DRY CONTACT	N/A	N/A	I-50-601	26 32 13	TRIP POINT PROVIDED BY ENGINE-GENERATOR MANUFACTURER

SECTION 40 64 00 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers programmable logic controllers (PLCs), including associated input/output hardware to control process equipment and serve as the interface to field devices.

B. Control System

1. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Software Control Block Descriptions section.

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. Supplementing this section, the Drawings indicate the number and types of PLCs, locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

D. I/O List

1. An input/output (I/O) field device signal listing is included as an appendix attached to section 40 61 11.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage, and shipping shall be as specified in the Instrumentation and Control System section.

1.5 SPARE PARTS

A. Spare parts shall be furnished as follows:

Spare Part	Quantity
Processor modules	1 of each type used
Power supply modules	1 of each type used
I/O modules	1 of each type used
Communications modules	1 of each type used

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment furnished under this section shall be expressly selected by System Supplier for its superior quality for the intended purpose and shall comply with the following requirements.

B. Interchangeability

1. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

C. Initial, Spare, and Future Memory (RAM)

1. System Supplier shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

2. Each programmable logic controller shall include provisions for future expansion and shall have 50 percent spare memory capacity and 50 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

D. Spare I/O

1. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 20 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks, communication adapters, cables, or PLC power supplies.

E. Expandability

1. Each PLC processor and associated I/O shall have a future expandability of at least 50 percent of the provided system.

F. Acceptable Manufacturers

1. The PLCs shall be Allen-Bradley ControlLogix without exception.

G. Signal Power Supplies

1. Regulated dc power supplies shall be provided in each PLC enclosure for analog inputs, digital outputs, digital inputs, analog outputs. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section.

2. The loop power supply shall be separate from the power supply circuit for the processor and racks.

3. The power source for all digital inputs from field devices shall be separately fused for each digital input module. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

H. Appurtenances

1. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the control system block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed for proper operation of the equipment.

I. PLC Arrangement

1. The PLCs shall be distributed and arranged as indicated on the Drawings.

J. Service Conditions

1. PLCs will be installed in air conditioned rooms.

2.2 LARGE PLC PROCESSOR

A. The programmable logic controller processor shall be an industrial-type rack-mounted unit that utilizes nonvolatile type memory. Battery-backed memory is not acceptable. Each processor shall include onboard nonvolatile memory and a secure removable secure digital (SD) card for storage and program backup of the user program. The processor shall automatically download the user program from nonvolatile memory upon startup after a power loss. Nonvolatile memory shall be programmable by the PLC or PLC software.

B. Each processor shall be provided with removeable secure digital (SD) card for program storage. The SD card shall be sized to back up the processor memory.

C. Diagnostics

1. The processor shall utilize self-monitoring diagnostic techniques and shall contain easily visible LED diagnostic indicators for "run" and "halt" conditions as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

D. Programming Port

1. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional, and after all communications, human machine interface (HMI), and process control network connections have been made. Removal or disruption of process control network communications, remote I/O communications, and HMIs to allow for on-line programming and monitoring will not be acceptable.

E. Communications

1. The processor shall be programmed to operate autonomously, regardless of communications status with other units. Each programmable controller shall be furnished complete with communication modules for local and remote input/output hardware communications, communications with other programmable controllers, and communication with host computers as shown on the block diagram.

F. Environment

1. The processor shall be suitable for operation in the environments specified in another section.

G. Programming

1. The processor shall be programmable using the IEC 61131 international programming standards and ladder logic programming. IEC 61131 programming shall include the following:

a. Functional Block Diagram
b. Sequential Function Chart.
c. Instruction List.
d. Structured Text.
e. Ladder Diagram.

2. Ladder logic programming shall include a minimum of the following capabilities:

a. Contacts, coils, branching.
b. Data comparisons.
c. On-delay and off-delay timers.
d. Counters with comparators.
e. Floating point Math and Logical instructions.
f. PID loop control.
g. Jumps and Subroutine functions.
h. Master control relay.
i. Transitional or one-shot outputs.
j. Standard and user-defined data tables for digital and analog value storage.
k. Remote I/O capability.
l. Fault-mode subroutine.

H. Programming Capabilities

1. The processor shall include the following capabilities for programming, debugging of programs, and troubleshooting.

a. Off-line programming.
b. On-line programming.
c. On-line status of coils and registers.
d. Input/output forcing.

I. Hardware Configuration

1. Processors shall be configured for standard rack mounting. Each programmable logic controller processor shall be provided with integrated and/or module-based communication interfaces as required to support Ethernet/IP communications with the programming device, HMI, Remote I/O and other networked systems.

J. Input/Output Hardware

1. Input/output hardware shall be arranged as indicated on the Drawings. Programmable logic controller systems shall support the following types of input/output modules.

a. 120 volt ac digital input and output.
b. 24 volt dc digital input and output.
c. 4-20 mA dc analog input and output.
d. High speed pulse accumulator input.
e. Platinum RTD analog input.

2. All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet the input/output hardware requirements specified herein.

3. Wiring Terminals

    a. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

4. I/O Circuit Power Supply

    a. Outputs for motor driven equipment will typically be powered from the driven equipment. Digital outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the Drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate either interposing relays or relay-type digital output modules in the PLC cabinet.

5. Digital Input Modules

    a. Digital input modules shall sense voltages between 100 and 130 volts ac and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Digital input modules shall provide electrical isolation with manufacturer standard between individual inputs. Digital input modules shall have multiple inputs.

6. Digital Output Modules

    a. Digital output modules shall control voltages from 100 and 130volts ac and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA. Digital output modules shall provide electrical isolation with manufacturer standard between individual output circuits. Digital output modules shall have multiple outputs.

7. Relay Digital Output Modules

    a. Where indicated on the PLC input/output listing, digital output modules shall have dry contact relay type outputs suitable to control voltages from 24 to 110 volts dc and 24 to 230 volts ac and shall be rated at least 2 amperes. Outputs have LED indicators to display output status. Digital outputs for motor driven equipment shall be powered by the driven equipment. Outputs shall withstand a surge of at

least 80 amperes for 15 milliseconds. Relay digital output modules shall have multiple outputs.

8. Analog Input Modules

   a. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 16-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs. Each input shall be isolated with manufacturer standard from the other inputs.

9. Analog Output Modules

   a. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 116-bit (0-4095 count) resolution. Analog output modules shall have multiple outputs.

10. Panel Terminations

   a. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

11. Interposing Relays

   a. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, where required by the application to isolate foreign power sources, where the continuous output rating of the PLC relay digital or output module is not sufficient to power the connected device or equipment, or where otherwise required by the System Supplier's equipment. One interposing relay shall be provided for each digital output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2.3 COMMUNICATIONS

A. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware.

B. PLC Communication shall be via Ethernet/IP over a radio communication system as indicated on the drawings. Ethernet components and cable are specified in other specification sections.

C. Addressability

1. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. IP addressing shall be used. Designation of a

controller's process control network address may be either a software or hardware function.

D. Communications Hardware

1. System Supplier shall provide all necessary communications hardware, including ethernet interfaces, industrial radios, antennas, cabling, and associated accessories necessary for a complete and operational communication link.

E. Communications Media

1. System Supplier shall provide all necessary cabling for the process control network**.** Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules. PLC communications media shall be as specified under the Metallic Communication Cable and Connectors section and Fiber Optic Communication Cable and Equipment section.

2.4 PROGRAMMING SOFTWARE

A. System Supplier shall furnish one licensed copy of PLC programming software for the Owner and one licensed copy for the Engineer. The software shall be suitable for running on a laptop computer running Windows 10 operating system software. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

B. Standard Product

1. The programming software shall be personal computer based and a standard product of the PLC manufacturer. The software shall be Allen Bradley RSLogix Studio 5000 Logix Designer Professional Edition

C. PLC Simulation

1. The programming software shall include a PLC simulation feature that allows the program logic of a single PLC to be tested and debugged entirely in the programming device without the PLC.

D. Programming Software Features

1. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by System Supplier shall also be included.

2. On-line features shall include IEC-61131 standards program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring

and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2.5 SYSTEM ENCLOSURES

A. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the Drawings and as described in the Panels, Consoles, and Appurtenances section.

2.6 OPERATOR INTERFACE TERMINALS

A. Operator interface terminals (OIT) shall be microprocessor-based flat panel type. The unit shall have data entry capabilities and shall include a password security function. The unit shall be connected to the PLC and shall display status, alarm, and diagnostic information. The unit shall provide a nominal diagonal display area dimension of 12", with a minimum resolution of 1200X800, 18-bit color, and a luminance of 400 cd/m^2. The OIT shall be furnished with a minimum of 4 GB of RAM and 3 GB of system memory. The operator interface unit shall be provided with Ethernet ports for communication and programming. The OIT shall be rated NEMA 4X, suitable for panel face.

B. Terminals shall be powered from 24 V dc power source. Terminals shall be suitable for ambient temperatures of +32 to +130°F and a relative humidity of 5 to 95 percent.

C. One licensed copy of the OIT software used to create the screens shall be turned over to the Owner upon successful startup and commissioning of the system.

D. The operator interface unit shall be an Allen-Bradley PanelView Plus 7 Performance model, or equal.

E. OIT shall provide graphic screens that shall be used by the operators to access all functions and setpoints necessary for comprehensive control. The Manufacturer shall be responsible for developing and configuring the custom graphic displays. Each piece of major process equipment that is monitored and controlled by the control system shall be displayed on the graphic screens. Graphic screens shall be representations of the equipment and piping. The screens must accurately show all devices and equipment that is part of the control loops. The manufacturer shall use the configuration standards and conventions to be established by direct coordination with the Owner that shall describe and define such items as proposed graphic display process line colors/representations; color standards for "on", "off", "opened", "closed", and "alarm" conditions; alarm handling conventions; how items will be selected for control; methods for navigation between displays; address usage/naming conventions; and security setup. Proposed displays shall be submitted to the Engineer and Owner for approval.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. PLCs installation requirements are specified in Instrumentation and Control System section except as described herein.

B. Field check, testing, and training shall be as specified in the Instrumentation and Control System section.

3.2 CONFIGURATION

A. PLC Programming and Configuration

1. Configuration services are specified in the Instrumentation and Control System section.

B. Communications Configuration

1. The communications shall be fully configured and installed by System Supplier, and shall be operational before application software configuration by others. Communications shall be configured as shown on the Drawings.

End of Section

Schedule 40 64 00.S01
Input/Output Schedule

Input/Output List - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.
Type. This is the type of I/O signal, as follows:
AI = Analog Input
AO = Analog Output
DI = Discrete Input
DO = Discrete Output
Loop No. This is a sequential number for a given type within a specific controller.
Description. This is the description or the function (i.e. Filter 1 Loss-of-Head).
Field Device. This is the tag number of equipment identifier associated with the I/O point.
Controller ID. This is the panel identification for the I/O cabinet, PLC cabinet, or controller where the I/O signal terminates.
Analog Data (Signal Type). This will typically be 4-20mA, but could also be 1-5Vdc, serial, Network (Modbus TCP, MODBUS TCP/IP/IP), HART, BUS, or similar to indicate the signal type of the associated input or output.
Analog Data (Calibrated Range). This will be the scaled value of the input in engineering units.
Analog Data (Power). This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.
Discrete Data (Signal Type). This will be 120VAC, 120VAC, or similar to indicate the signal type of the associated input or output.
Discrete Data (Closed State). This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).
Discrete Data (Power Source). This will indicate the location of the power source for the wetting voltage on the contacts, as follows:
Field = External field power source. (May require interposing relays or isolated I/O module type.)
PLC = Power originates from within the PLC or I/O enclosure.
Discrete Data (Interp Relay). This will be either 'Yes' or 'No' to indicate whether the input or output requires an interposing relay. Relays are typically required to isolate external voltage sources. See specifications for additional details.
P&ID Drawing. This is the P&ID drawing the I/O point can be found on.
Remarks. This column may include a cross reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the end of the I/O listing.

							Analog Data			Discrete Data					
Item	Type	IO Code	Loop No.	Description	Field Device	Controller ID	Signal Type	Calibrated Range	Power Type	Signal Type	Closed State	Power Source	Interp	P&ID Drawing	Remarks
1	AI	LI	1511	WIDOWS CREEK WETWELL 1 LEVEL	COLW-LIT-1511	EXISTING PLC	4-20 mA DC	0-11 FT	2-WIRE	N/A	N/A	N/A	N/A	I-15-601	
2	DI	LAL	1511	WIDOWS CREEK WETWELL 1 LOW LEVEL	COLW-LSL-1511	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
3	DI	LAH	1511	WIDOWS CREEK WETWELL 1 HIGH LEVEL	COLW-LSH-1511	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
4	AI	LI	1521	WIDOWS CREEK WETWELL 2 LEVEL	COLW-LIT-1521	EXISTING PLC	4-20 mA DC	0-11 FT	2-WIRE	N/A	N/A	N/A	N/A	I-15-601	
5	DI	LAL	1521	WIDOWS CREEK WETWELL 2 LOW LEVEL	COLW-LSL-1521	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
6	DI	LAH	1521	WIDOWS CREEK WETWELL 2 HIGH LEVEL	COLW-LSH-1521	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
7	AI	FI	1500	WIDOWS CREEK PUMPS HEADER TO BRIDGEPORT WWTP CHLORINE CONTACT BASIN FLOW	COLW-FIT-1500	EXISTING PLC	4-20 mA DC	0-8000 GPM	2-WIRE	N/A	N/A	N/A	N/A	I-15-601	
8	DI	YI	1510	WIDOWS CREEK WETWELL 1 PUMP IN REMOTE	COLW-PVT-1510	EXISTING PLC	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-15-601	
9	DI	YIR	1510	WIDOWS CREEK WETWELL 1 PUMP RUNNING	COLW-PVT-1510	EXISTING PLC	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-15-601	
10	DI	UA	1510	WIDOWS CREEK WETWELL 1 PUMP COMMON FAIL	COLW-PVT-1510	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
11	DI	UCR	1510	WIDOWS CREEK WETWELL 1 PUMP RUN COMMAND	COLW-PVT-1510	EXISTING PLC	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-15-601	
12	DI	UCS	1510	WIDOWS CREEK WETWELL 1 PUMP STOP COMMAND	COLW-PVT-1510	EXISTING PLC	N/A	N/A	N/A	120 VAC	STOP CMD	FIELD	YES	I-15-601	
13	AI	SI	1510	WIDOWS CREEK WETWELL 1 PUMP SPEED INDICATION	COLW-PVT-1510	EXISTING PLC	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-15-601	
14	AO	SC	1510	WIDOWS CREEK WETWELL 1 PUMP SPEED COMMAND	COLW-PVT-1510	EXISTING PLC	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-15-601	
15	DI	PAH	1511	WIDOWS CREEK WETWELL 1 PUMP HIGH DISCHARGE PRESSURE	COLW-PSH-1511	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
16	DI	YI	1520	WIDOWS CREEK WETWELL 2 PUMP IN REMOTE	COLW-PVT-1520	EXISTING PLC	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-15-601	
17	DI	YIR	1520	WIDOWS CREEK WETWELL 2 PUMP RUNNING	COLW-PVT-1520	EXISTING PLC	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-15-601	
18	DI	UA	1520	WIDOWS CREEK WETWELL 2 PUMP COMMON FAIL	COLW-PVT-1520	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
19	DI	UCR	1520	WIDOWS CREEK WETWELL 2 PUMP RUN COMMAND	COLW-PVT-1520	EXISTING PLC	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-15-601	
20	DI	UCS	1520	WIDOWS CREEK WETWELL 2 PUMP STOP COMMAND	COLW-PVT-1520	EXISTING PLC	N/A	N/A	N/A	120 VAC	STOP CMD	FIELD	YES	I-15-601	
21	AI	SI	1520	WIDOWS CREEK WETWELL 2 PUMP SPEED INDICATION	COLW-PVT-1520	EXISTING PLC	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-15-601	
22	AO	SC	1520	WIDOWS CREEK WETWELL 2 PUMP SPEED COMMAND	COLW-PVT-1520	EXISTING PLC	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-15-601	
23	DI	PAH	1521	WIDOWS CREEK WETWELL 2 PUMP HIGH DISCHARGE PRESSURE	COLW-PSH-1521	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
24	DI	YA	1550	WIDOWS CREEK PS HEATING SYSTEM FAIL	COLW-TPS-1550	EXISTING PLC	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-15-601	
25	DI	YIR		INFLUENT POND FLOATING BRUSH EXISTING AERATOR 1 RUNNING	LAG-AFS-XXXX	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
26	DI	YIR		INFLUENT POND FLOATING BRUSH EXISTING AERATOR 2 RUNNING	LAG-AFS-XXXX	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
27	DI	YIR	2001	INFLUENT POND INLET FLOATING BRUSH AERATOR 1 RUNNING	LAG-AFS-2001	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
28	DI	YIR	2002	INFLUENT POND INLET FLOATING BRUSH AERATOR 2 RUNNING (FUTURE)	LAG-AFS-2002	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	FUTURE I/O
29	DI	YIR	2003	INFLUENT POND INLET FLOATING BRUSH AERATOR 3 RUNNING (FUTURE)	LAG-AFS-2003	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	FUTURE I/O
30	DI	YIR	2004	INFLUENT POND INLET FLOATING BRUSH AERATOR 4 RUNNING	LAG-AFS-2004	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
31	DI	YIR	2005	INFLUENT POND INLET FLOATING BRUSH AERATOR 5 RUNNING	LAG-AFS-2005	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
32	DI	YIR	2006	INFLUENT POND INLET FLOATING BRUSH AERATOR 6 RUNNING (FUTURE)	LAG-AFS-2006	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	FUTURE I/O
33	DI	YIR	2011	POLISHING POND FLOATING BRUSH AERATOR 1 RUNNING	LAG-AFS-2011	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
34	DI	YIR	2012	POLISHING POND FLOATING BRUSH AERATOR 2 RUNNING	LAG-AFS-2012	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-20-601	
35	AI	LI	3001	CHLORINE CONTACT BASIN LEVEL	TE-LIT-3001	PLC-4000	4-20 mA DC	0-15 FT	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
36	AI	AI	3001	CHLORINE CONTACT BASIN INLET CHLORINE	TE-AIT-3001	PLC-4000	4-20 mA DC	0-4 mg/L	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
37	AI	AI	3002	CHLORINE CONTACT BASIN PARSHALL FLUME CHLORINE	TE-AIT-3002	PLC-4000	4-20 mA DC	0-1 mg/L	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
38	AI	FI	3002	CHLORINE CONTACT BASIN PARSHALL FLUME FLOW	TE-FIT-3002	PLC-4000	4-20 mA DC	0-4 MGD	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
39	AI	AI	3003	CHLORINE CONTACT BASIN PARSHALL FLUME pH	TE-AIT-3003	PLC-4000	4-20 mA DC	0-9 S.U.	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
40	AI	FI	3001	FLOW FROM GOOGLE TO CHLORINE CONTACT BASIN LINE FLOW	TE-FIT-3001	PLC-4000	4-20 mA DC	0-8,000 GPM	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
41	AI	AI	3004	CHLORINE CONTACT BASIN OUTLET CHLORINE	TE-AIT-3004	PLC-4000	4-20 mA DC	0-2 mg/L	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
42	AI	AI	3005	CHLORINE CONTACT BASIN PARSHALL FLUME DISSOLVED OXYGEN	TE-AIT-3005	PLC-4000	4-20 mA DC	0-10 mg/L	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
43	AI	TI	3006	FLOW FROM GOOGLE TO CHLORINE CONTACT BASIN LINE TEMPERATURE	COLW-AIT-3006	PLC-4000	4-20 mA DC	0-100° F	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
44	AI	AI	3006	FLOW FROM GOOGLE TO CHLORINE CONTACT BASIN LINE pH	COLW-AIT-3006	PLC-4000	4-20 mA DC	0-12	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
45	AI	AI	3007	FLOW FROM GOOGLE TO CHLORINE CONTACT BASIN LINE ALK	COLW-AIT-3007	PLC-4000	4-20 mA DC	0-1,000 mg/L	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
46	DI	LAH	3001	CHLORINE CONTACT BASIN HIGH LEVEL	TE-LIT-3001	PLC-4000	N/A	N/A	N/A	120 VAC	HI LEVEL	PLC	NO	I-30-601	
47	AI	LI	3000	CHLORINE CONTACT BASIN JUNCTION STRUCTURE LEVEL	TE-LIT-3000	PLC-4000	4-20 mA DC	0-15 FT	2-WIRE	N/A	N/A	N/A	N/A	I-30-601	
48	DI	ZIO	3001	CHLORINE CONTACT BASIN JUNCTION STRUCTURE WEIR GATE OPENED	TE-G-3001	PLC-4000	N/A	N/A	N/A	120 VAC	OPENED	PLC	NO	I-30-601	
49	DI	ZIC	3001	CHLORINE CONTACT BASIN JUNCTION STRUCTURE WEIR GATE CLOSED	TE-G-3001	PLC-4000	N/A	N/A	N/A	120 VAC	CLOSED	PLC	NO	I-30-601	
50	DI	YI	3001	CHLORINE CONTACT BASIN JUNCTION STRUCTURE WEIR GATE IN REMOTE	TE-G-3001	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-30-601	
51	AI	ZI	3001	CHLORINE CONTACT BASIN JUNCTION STRUCTURE WEIR GATE POSITION INDICATION	TE-G-3001	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
52	AI	ZC	3001	CHLORINE CONTACT BASIN JUNCTION STRUCTURE WEIR GATE POSITION COMMAND	TE-G-3001	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-30-601	
53	AI	WI	4001	SULFURIC ACID STORAGE TOTE SCALE 1 WEIGHT	HSO4-WIT-4001	PLC-4000	4-20 mA DC	0-8,500 LBS	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
54	AI	WI	4002	SULFURIC ACID STORAGE TOTE SCALE 2 WEIGHT	HSO4-WIT-4002	PLC-4000	4-20 mA DC	0-8,500 LBS	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
55	AI	NI	4010	SULFURIC ACID METERING PUMP NO. 1 STROKE LENGTH	HSO4-PDM-4010	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
56	AI	SI	4010	SULFURIC ACID METERING PUMP NO. 1 SPEED INDICATION	HSO4-PDM-4010	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
57	AI	SI	4020	SULFURIC ACID METERING PUMP NO. 2 SPEED INDICATION	HSO4-PDM-4020	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
58	AI	NI	4020	SULFURIC ACID METERING PUMP NO. 2 STROKE LENGTH	HSO4-PDM-4020	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
59	AO	SC	4010	SULFURIC ACID METERING PUMP NO. 1 SPEED COMMAND	HSO4-PDM-4010	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
60	AO	NC	4010	SULFURIC ACID METERING PUMP NO. 1 STROKE COMMAND	HSO4-PDM-4010	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
61	AO	SC	4020	SULFURIC ACID METERING PUMP NO. 2 SPEED COMMAND	HSO4-PDM-4020	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
62	AO	NC	4020	SULFURIC ACID METERING PUMP NO. 2 STROKE COMMAND	HSO4-PDM-4020	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-601	
63	DI	YI	4010	SULFURIC ACID METERING PUMP NO. 1 IN REMOTE	HSO4-PDM-4010	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-601	
64	DI	YIR	4010	SULFURIC ACID METERING PUMP NO. 1 RUNNING	HSO4-PDM-4010	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-40-601	
65	DI	UA	4010	SULFURIC ACID METERING PUMP NO. 1 COMMON FAIL	HSO4-PDM-4010	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-601	
66	DI	PAH	4011	SULFURIC ACID METERING PUMP NO. 1 HI PRESSURE	HSO4-PSH-4011	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	NO	I-40-601	

							Analog Data			Discrete Data					
Item	Type	IO Code	Loop No.	Description	Field Device	Controller ID	Signal Type	Calibrated Range	Power Type	Signal Type	Closed State	Power Source	Interp	P&ID Drawing	Remarks
67	DI	YI	4020	SULFURIC ACID METERING PUMP NO. 2 IN REMOTE	HSO4-PDM-4020	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-601	
68	DI	YIR	4020	SULFURIC ACID METERING PUMP NO. 2 RUNNING	HSO4-PDM-4020	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-40-601	
69	DI	UA	4020	SULFURIC ACID METERING PUMP NO. 2 COMMON FAIL	HSO4-PDM-4020	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-601	
70	DI	PAH	4021	SULFURIC ACID METERING PUMP NO. 2 HI PRESSURE	HSO4-PSH-4021	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	NO	I-40-601	
71	DO	UCR	4010	SULFURIC ACID METERING PUMP NO. 1 RUN COMMAND	HSO4-PDM-4010	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-40-601	
72	DO	UCR	4020	SULFURIC ACID METERING PUMP NO. 2 RUN COMMAND	HSO4-PDM-4020	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-40-601	
73	DI	FAH	4000	SULFURIC ACID STORAGE TANKS AREA EMERGENCY EYEWASH ACTIVATED	HSO4-FSH-4000	PLC-4000	N/A	N/A	N/A	120 VAC	EYEWASH/SHOWER ACTIVATED	PLC	NO	I-40-601	
74	DI	FAL	4001	SERVICE WATER TO SULFURIC ACID DILUTION PANEL LOW FLOW	HSO4-FSL-4001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-601	
75	DI	TAH	4001	SERVICE WATER TO SULFURIC ACID DILUTION PANEL HIGH TEMPERATURE	HSO4-TSH-4001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-601	
76	AI	LI	4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 LEVEL	NOCL-LIT-4101	PLC-4000	4-20 mA DC	0-15 FT	2-WIRE	N/A	N/A	N/A	N/A	I-40-603	
77	DI	FAH	4100	SODIUM HYPOCHLORITE STORAGE TANKS AREA EMERGENCY EYEWASH 1 ACTIVATED	NOCL-FSH-4100	PLC-4000	N/A	N/A	N/A	120 VAC	EYEWASH/SHOWER ACTIVATED	PLC	NO	I-40-603	
78	DI	LAH	4100	SODIUM HYPOCHLORITE STORAGE TANKS AREA CONTAINMENT HIGH LEVEL	NOCL-LSH-4100	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-603	
79	DI	LAH	4101	SODIUM HYPOCHLORITE STORAGE TANK NO. 1 HIGH LEVEL	NOCL-LIT-4101	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-603	
80	DI	FAH	4101	SODIUM HYPOCHLORITE STORAGE TANKS AREA EMERGENCY EYEWASH 2 ACTIVATED	NOCL-FSH-4101	PLC-4000	N/A	N/A	N/A	120 VAC	EYEWASH/SHOWER ACTIVATED	PLC	NO	I-40-603	
81	AI	SI	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 SPEED INDICATION	NOCL-PDM-4110	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
82	AI	NI	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 STROKE LENGTH	NOCL-PDM-4110	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
83	AI	NI	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 STROKE LENGTH	NOCL-PDM-4120	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
84	AI	SI	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 SPEED INDICATION	NOCL-PDM-4120	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
85	AO	SC	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 SPEED COMMAND	NOCL-PDM-4110	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
86	AO	NC	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 STROKE COMMAND	NOCL-PDM-4110	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
87	AO	SC	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 SPEED COMMAND	NOCL-PDM-4120	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
88	AO	NC	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 STROKE COMMAND	NOCL-PDM-4120	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-604	
89	DI	YI	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 IN REMOTE	NOCL-PDM-4110	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-604	
90	DI	YIR	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 RUNNING	NOCL-PDM-4110	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-40-604	
91	DI	UA	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 COMMON FAIL	NOCL-PDM-4110	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-604	
92	DI	PAH	4111	SODIUM HYPOCHLORITE METERING PUMP NO. 1 DISCHARGE HIGH PRESSURE	NOCL-PSH-4111	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	N/A	I-40-604	
93	DI	UA	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 COMMON FAIL	NOCL-PDM-4120	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-604	
94	DI	YIR	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 RUNNING	NOCL-PDM-4120	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-604	
95	DI	YI	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 IN REMOTE	NOCL-PDM-4120	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-604	
96	DI	PAH	4121	SODIUM HYPOCHLORITE METERING PUMP NO. 2 DISCHARGE HIGH PRESSURE	NOCL-PSH-4121	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	N/A	I-40-604	
97	DO	UCR	4110	SODIUM HYPOCHLORITE METERING PUMP NO. 1 RUN COMMAND	NOCL-PDM-4110	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-40-604	
98	DO	UCR	4120	SODIUM HYPOCHLORITE METERING PUMP NO. 2 RUN COMMAND	NOCL-PDM-4120	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	PLC	YES	I-40-604	
99	DI	UA	4000	WWTP FIRE ALARM FAULT	NOCL-FACP-4000	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-604	
100	AI	LI	4201	SODIUM BISULFITE STORAGE TANK LEVEL	NHS-LIT-4201	PLC-4000	4-20 mA DC	0-15 FT	2-WIRE	N/A	N/A	N/A	N/A	I-40-605	
101	DI	FAH	4200	SODIUM BISULFITE STORAGE TANK AREA EMERGENCY EYEWASH SHOWER ACTIVATED	NHS-FSH-4200	PLC-4000	N/A	N/A	N/A	120 VAC	EYEWASH/SHOWER ACTIVATED	PLC	NO	I-40-605	
102	DI	LAH	4200	SODIUM BISULFITE STORAGE TANK CONTAINMENT HIGH LEVEL	NHS-LSH-4200	PLC-4000	N/A	N/A	N/A	120 VAC	HIGH LEVEL	PLC	NO	I-40-605	
103	DI	LAH	4201	SODIUM BISULFITE STORAGE TANK HIGH LEVEL	NHS-LIT-4201	PLC-4000	N/A	N/A	N/A	120 VAC	HIGH LEVEL	PLC	NO	I-40-605	
104	DI	UA	0001	CHEMICAL BUILDING MAKEUP AIR UNIT 40-MAU-0001 HIGH PRESSURE	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
105	DI	UA	0001A	CHEMICAL BUILDING POSITIVE PRESSURIZATION UNIT 40-PPU-0001 HIGH PRESSURE	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
106	DI	UA	0001B	CHEMICAL BUILDING MAKEUP AIR UNIT 40-MAU-0001 VENTILATION SYSTEM FAIL	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
107	DI	UA	0001C	CHEMICAL BUILDING EXHAUST FAN 40-EF-0001 VENTILATION SYSTEM FAIL	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
108	DI	UA	0003	CHEMICAL BUILDING EXHAUST FAN 40-EF-0003 VENTILATION SYSTEM FAIL	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
109	DI	UA	0001D	CHEMICAL BUILDING MAKEUP AIR UNIT 40-MAU-0001 LOW AIR TEMPERATURE	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
110	DI	UA	0001E	CHEMICAL BUILDING 40-MAU-0001 & 40-EF-0001 & 40-EF-0003 EMERGENCY VENTILATION SHUTOFF 1	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
111	DI	UA	0001F	CHEMICAL BUILDING 40-MAU-0001 & 40-EF-0001 & 40-EF-0003 EMERGENCY VENTILATION SHUTOFF 2	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
112	DI	UA	0001G	CHEMICAL BUILDING 40-MAU-0001 & 40-EF-0001 & 40-EF-0003 EMERGENCY VENTILATION SHUTOFF 3	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
113	DI	UA	0002	CHEMICAL BUILDING 40-EF-0002 (CURRENT SENSOR SWITCHES) VENTILATION SYSTEM FAIL	40-TCP-0001	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
114	AI	NI	4220	SODIUM BISULFITE METERING PUMP NO. 2 STROKE LENGTH	NHS-PDM-4220	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
115	AI	SI	4220	SODIUM BISULFITE METERING PUMP NO. 2 SPEED INDICATION	NHS-PDM-4220	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
116	AI	SI	4210	SODIUM BISULFITE METERING PUMP NO. 1 SPEED INDICATION	NHS-PDM-4210	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
117	AI	NI	4210	SODIUM BISULFITE METERING PUMP NO. 1 STROKE LENGTH	NHS-PDM-4210	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
118	AO	SC	4220	SODIUM BISULFITE METERING PUMP NO. 2 SPEED COMMAND	NHS-PDM-4220	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
119	AO	NC	4220	SODIUM BISULFITE METERING PUMP NO. 2 STROKE COMMAND	NHS-PDM-4220	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
120	AO	SC	4210	SODIUM BISULFITE METERING PUMP NO. 1 SPEED COMMAND	NHS-PDM-4210	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
121	AO	NC	4210	SODIUM BISULFITE METERING PUMP NO. 1 STROKE COMMAND	NHS-PDM-4210	PLC-4000	4-20 mA DC	0-100%	4-WIRE	N/A	N/A	N/A	N/A	I-40-606	
122	DI	UA	4220	SODIUM BISULFITE METERING PUMP NO. 2 COMMON FAIL	NHS-PDM-4220	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
123	DI	YI	4220	SODIUM BISULFITE METERING PUMP NO. 2 IN REMOTE	NHS-PDM-4220	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-606	
124	DI	YIR	4220	SODIUM BISULFITE METERING PUMP NO. 2 RUNNING	NHS-PDM-4220	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-40-606	
125	DI	PAH	4221	SODIUM BISULFITE METERING PUMP NO. 2 DISCHARGE HIGH PRESSURE	NHS-PSH-4221	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	NO	I-40-606	
126	DI	YIR	4210	SODIUM BISULFITE METERING PUMP NO. 1 RUNNING	NHS-PDM-4210	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-40-606	
127	DI	UA	4210	SODIUM BISULFITE METERING PUMP NO. 1 COMMON FAIL	NHS-PDM-4210	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-40-606	
128	DI	YI	4210	SODIUM BISULFITE METERING PUMP NO. 1 IN REMOTE	NHS-PDM-4210	PLC-4000	N/A	N/A	N/A	120 VAC	IN REMOTE	PLC	NO	I-40-606	
129	DI	PAH	4211	SODIUM BISULFITE METERING PUMP NO. 1 DISCHARGE HIGH PRESSURE	NHS-PSH-4211	PLC-4000	N/A	N/A	N/A	120 VAC	HI PRESSURE	PLC	NO	I-40-606	
130	DO	UCR	4220	SODIUM BISULFITE METERING PUMP NO. 2 RUN COMMAND	NHS-PDM-4220	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-40-606	
131	DO	UCR	4210	SODIUM BISULFITE METERING PUMP NO. 1 RUN COMMAND	NHS-PDM-4210	PLC-4000	N/A	N/A	N/A	120 VAC	RUN CMD	FIELD	YES	I-40-606	
132	DI	YIR	5000	ENGINE GENERATOR COMMON RUNNING	FUE-LCP-5000	PLC-4000	N/A	N/A	N/A	120 VAC	RUNNING	PLC	NO	I-50-601	
133	DI	YI	5000	ENGINE GENERATOR ATS EMERGENCY CONNECTION	FUE-ATS-5000	PLC-4000	N/A	N/A	N/A	120 VAC	EMERGENCY CONNECTION	PLC	NO	I-50-601	
134	DI	UA	5000	ENGINE GENERATOR COMMON FAIL	FUE-LCP-5000	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL	PLC	NO	I-50-601	
135	DI	YI	5000A	ENGINE GENERATOR ATS NORMAL CONNECTION	FUE-ATS-5000	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL CONNECTION	PLC	NO	I-50-601	
136	DI	YI	5000B	ENGINE GENERATOR EMERGENCY POWER AVAILABLE	FUE-ATS-5000	PLC-4000	N/A	N/A	N/A	120 VAC	EMERGENCY POWER AVAILABLE	PLC	NO	I-50-601	
137	DI	YI	5000C	ENGINE GENERATOR NORMAL POWER AVAILABLE	FUE-ATS-5000	PLC-4000	N/A	N/A	N/A	120 VAC	NORMAL POWER AVAILABLE	PLC	NO	I-50-601	
138	DI	UA	5001	ENGINER GENERATOR EMERGENCY STOP	FUE-HS-5001	PLC-4000	N/A	N/A	N/A	120 VAC	ESTOP	PLC	NO	I-50-601	

SECTION 40 66 11 – PROCESS CONTROL NETWORK SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of all hardware and software for process control network systems. Principal components of the network systems shall be as indicated on the Drawings and as described below.

1. Communications between the existing pump stations, the new PLC located at the Chemical Building, and the existing plant SCADA system

2. Communication from the existing pump stations to the Chemical Building PLC shall be via fiber optic cable as indicated on the Drawings. Communication between the Chemical Building PLC and the WTP SCADA system shall be via a radio communication system

3. The network shall utilize Ethernet-based communications to support data exchange between PLCs, network switches, radio equipment, and other network-connected devices as required.

B. System Supplier shall furnish all necessary network equipment, interconnecting cables, accessories, software, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the System Supplier.

C. Equipment and services provided under the Network Systems section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings.

D. Control System

1. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.

E. Network Functional Description

1. The process control network system shall provide communications between the operator workstations, servers, network switches, fire walls, routers, and PLCs.

1.2 GENERAL

A. System Supplier shall select the process control network equipment for its superior quality and the intended performance. The System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.

D. Governing Standards

1. Governing Standards for process control network systems shall be as specified in the Instrumentation and Control System section.

E. Power and Instrument Signals

1. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac. Where shown, network equipment shall be provided with backup power such as an uninterruptible power supply.

F. Appurtenances

1. Special or manufacturer specific power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.

G. Interchangeability and Appearance

1. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of spare parts. Whenever possible, identical units shall be furnished.

H. Programming Software

1. Software required for programming, shall be provided for systems that contain any equipment that requires software for routine maintenance and troubleshooting. The programming software shall be the latest version offered by the manufacturer, compatible with the equipment provided, and newly purchased for this project. Programming

software shall be turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

B. Network Design submittal (to be provided with the First Stage Submittals):

1. A complete process control network topology diagram, detailing all hardware, cabling and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

2. A complete listing of IP addresses to be assigned to all network and network connected equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner. Failure to provide this equipment IP addresses list with the First Stage Submittals could cause the submittal to be returned as unreviewed or rejected outright.

C. O&M Manuals.

1. All above documentation shall also be provided in the O&M manuals. The Ethernet Network Test reports described herein shall be provided with the Third Stage O&M submittals. Failure to provide the Ethernet Network Test reports with the Third Stage O&M submittals could cause the submittal to be returned as unreviewed or rejected outright.

1.4 DELIVERY, SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1.5 CONNECTION TO EXISTING OWNER NETWORKS

A. Network hardware and software provided shall be compatible with the Owner's existing process control network systems wherever a system interconnection is provided. System Supplier shall verify existing process control systems to ensure compatibility.

B. All connections to the Owner's existing network shall be fully coordinated between the Owner and the System Supplier. Prior to connecting to the existing network, the System Supplier shall provide a written request to the Owner for an Owner's representative to be available, along with facility approval as described below when existing systems are disconnected and at the time of any new connections.

1.6 COORDINATION WITH OWNER

A. The System Supplier shall coordinate all demolitions, installations and rework on the existing networks with the Owner and the Engineer. No work shall be performed without the written consent of the Owner. The System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum process control Ethernet network device stipulations.

2.2 NETWORK CABLING SPECIFICATIONS

A. Individual network equipment and related devices shall be coordinated with items provided in the following sections:

1. Metallic Communication Cable and Connectors section

2. Fiber Optic Communication Cable and Equipment section

2.3 ETHERNET NETWORK HARDWARE

A. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802.3 and 802.3u standards using copper wire or fiber optic strands. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending faults. Ethernet network switches shall be replaceable on-line without disrupting the network. Redundant Ethernet switches shall be provided where shown on the Drawings. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

B. Industrial (Panel-Mounted) Ethernet Switches

1. Managed Ethernet Switches.

a. Each Ethernet switch mounted in a process area enclosure shall be industrial grade managed switch and include the following functionality:
1) Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the connectivity and functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two (2**)** single mode SC fiber uplink ports.

SFP modules shall be provided as required. A minimum of four UTP ports shall be provided.

2) Each switch connection shall automatically sense the network speed of the devices to which it is connected.
3) Capable of ring-based media redundancy with 30 ms recovery time.
4) Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.
5) Prioritization: IEEE 802.1p QoS Support.
6) Network Segregation: Port VLAN.
7) Management: SNMPv3 and Browser-based management shall be supported.
8) IGMP snooping supported.
9) LED indication of the link activity for each port.
10) Environmental:
    a) Suitable for installation in industrial environments.
    b) Operating Temperature Range: -10 to 60°C. **[**Optional -40 to 60°C**]**
    c) Relative Humidity Range: 10 to 95%
11) Redundant 24 VDC power supply inputs
12) Conformal coating option for use in hazardous environments.
13) Mounting: DIN-rail mounted suitable for panel installation.
14) All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

b. Power over Ethernet (POE) switches shall have the following functionality:
    1) Power Enabling and standards: IEEE 812.3af
    2) Power: 48 VDC, 50 watt minimum power supply for power enabling switch.
    3) LED indication of the link activity for each port and power forwarding.

c. Switches shall be Cisco Catalyst IE3300 series, Hirschmann BRS-30 series, Moxa EDS-500 series, Red Lion N-Tron 700 series, With POE Injector , or approved equal.

C. Ethernet Connectors

1. Ethernet wiring connectors shall be RJ-45 male modular plug connectors.

2. Standard RJ45 Connectors

    a. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25º to 60º C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

3. Industrial RJ45 Connectors

    a. Industrial connectors shall be an eight position industrial connector for use in manufacturing environments. Connectors shall meet the TIA/EIA-568-B.2 standard for Cat-5e or Cat-6 requirements. The connector shall incorporate an IP67 rated seal and shall provide protection from dust and temporary immersion in water. A tethered protective cap shall be provided. The connector shall accept a

non-shielded Cat-5e or Cat-6 solid twisted pair cable. Connectors shall be Panduit, Belden, or approved equal.

4. Industrial RJ45 Receptacles

a. Industrial receptacles shall be an eight position industrial, panel mounted pass through receptacle. Receptacles shall meet the TIA/EIA-568-B.2 standard for Cat-5e or Cat-6 requirements. The receptacle shall incorporate an IP67 rated seal and shall provide protection from dust and temporary immersion in water. A tethered protective cap shall be provided. The receptacle shall accept a non-shielded Cat-5e or Cat-6 solid twisted pair cable. Receptacles shall be Panduit, Belden, or approved equal.

2.4 ETHERNET NETWORK SOFTWARE

A. All switches and routers shall be managed from a graphical user interface on a Microsoft Windows operating system computer. Network management software and all network equipment provided by the System Supplier shall be compatible with each other, allowing management of each device from the provided software. Network management software shall be approved by the Engineer and be the latest version of Cisco DNA Center, Hirschmann HiVision, Moxa MXview, Red Lion N-View,or approved equal.

2.5 SPARE PARTS

A. Spare parts shall be provided as specified below.

Spare parts	Quantity
Switches	1 of each type

PART 3 - EXECUTION

3.1 NETWORK INSTALLATION REQUIREMENTS

A. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3.2 NETWORK CONFIGURATION

A. The System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.

B. Ethernet Switches

1. The System Supplier shall fully configure all Ethernet switches. The following shall be configured:

a. For managed switches, unused ports shall be disabled for security purposes during the switch configuration via settings or software selection.
b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times and increase available bandwidth.
c. Management Password Security in accordance with the Owner's cyber security policy.
d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.
e. VLAN/subnet network segmentation.

C. Network Configuration Report

1. The System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments.

D. Management Software

1. Management software shall be fully configured for all network devices provided.

3.3 NETWORK TESTING

A. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.

B. Systems Check

1. A technical representative of System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.

C. Test Equipment

1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

2. Ethernet Network Minimum Test Requirements

a. The following minimum tests are to be performed by the System Supplier:

1) Verify Link Integrity Status LED is lit on both sides of each link. Refer to product manuals to confirm the LED status indication for each network interface card or network device.
2) Verify proper operation and failover of each redundant component and redundant link. Each redundant server, PLC, or other network hardware device shall be powered down or disconnected from the network to verify that the other device successfully takes control, and all functionality exists. For redundant network connections, each network connection shall be disconnected to verify that there is no loss of communication on the network.
3) Verify alarming of each link failure. Network failure alarms shall be configured within the network interface card software or other network device configuration software. For PLC communication, communication heartbeats shall be configured to detect a loss of communication, and alarms shall be configured when the heartbeat is not received. The generation of a communication alarm shall be confirmed for each network device.
4) Verify bandwidth usage of fully installed systems as part of the Operation Acceptance Testing as specified in the Commissioning section. The analysis of the network utilization and bandwidth usage shall be performed using SolarWinds NetFlow Traffic Analyzer or equivalent. Any concerns identified from the analysis shall be clearly identified with the recommended corrective actions.

3. Ethernet Network Test Reports

a. Upon completion and testing of the installed Ethernet network, the System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3.4 NETWORK TROUBLESHOOTING

A. It is the System Supplier's responsibility to provide trouble-free and reliable networks. The System Supplier shall employ any means necessary to ensure operational networks. The System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The System Supplier shall utilize the services of a trained and certified Network Engineer that is regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP).

End of Section

SECTION 40 66 33 - METALLIC COMMUNICATION CABLE AND CONNECTORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of metallic cable systems to provide communications for the Process Control Network System as indicated on the Drawings.

B. Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

C. Equipment and services provided under this section shall be subject to the requirements specified in the Instrumentation and Control System section and the Process Control Network Systems section. Supplementing the Metallic Communications Cable and Connectors section, special requirements and options are indicated on the Drawings.

D. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

E. The Work consists of providing all labor, services, materials, tools, equipment, and appurtenances necessary to furnish, install, test and commission a complete communications network.

1.2 QUALITY ASSURANCE.

A. General

1. It is the intent of these Specifications and of the Drawings to establish quality standards of all equipment and materials and to require first class workmanship.

2. All equipment and materials shall be new, free of defects and of the highest quality. No existing or used equipment is allowed.

3. All work shall be accomplished by qualified, experienced personnel working under continuous and competent supervision.

4. The Contractor shall apply and install materials, equipment, and specialties in accordance with manufacturers' written instructions.

5. Metallic communication cable system work shall conform to the construction schedule and the progress of other trades.

B. Referenced Standards

1. This Section references the latest revisions of the following standards. They are part of this Section as specified and modified. These shall govern, as applicable, the terminology, design, materials, construction, and the testing methods for the equipment specified in this Section. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

a. ANSI/IEEE Std. 100 - IEEE Standard, Dictionary of General and Electronic Terms
b. TIA/EIA 568-C.0 - Generic Telecommunications Cabling
c. RoHS 2011/65/EU - Restriction on the Use of Hazardous Substances
d. TIA/EIA-606-B - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
e. ANSI/SCTE 77 - Specification for Underground Enclosures Integrity
f. UL 969 - Standard for Marking and Labeling Systems

C. Codes and Regulations

1. This Section references the latest revision of the following codes. They are a part of this Section as specified and modified. Apparent conflicts between the Contract Documents and the listed codes shall be submitted to the Owner for resolution prior to ordering materials or performing affected work.

a. NEC - National Electrical Code (NFPA 70)
b. NESC - National Electrical Safety Code
c. UBC - Uniform Building Code

D. Measuring Equipment and Tools

1. Validity of measurements and tests shall be ensured through the use of suitable inspection, measuring and test equipment of the range and type necessary to determine conformance of items with the Contract requirements. Measuring devices shall be verified or calibrated against certified standards that have a known traceable relationship to the National Bureau of Standards. Every device verified or calibrated shall bear an indication attesting to the current status and showing the date on which inspection or re-calibration is next required. Tests shall not be conducted using test equipment having an expired calibration date. Any tests run with instruments not in compliance with the requirements in this paragraph shall be considered invalid.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

B. Qualifications

1. The name, address and telephone number of the proposed contractor or subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work

similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

C. Drawings and Data

1. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

2. Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for all metallic communication cabling used for the Process Control Network System (Cat 5e UTP, Cat 6 UTP, Cat 6 STP, Ethernet patch cables, PLC Communications Media, Industrial Communications Cabling, etc.)
b. Information shall include materials of construction and complete ordering information.
c. Product information shall be neatly marked to indicate only those items, options, model, or series of equipment which are being submitted for approval. All extraneous materials shall be crossed out.
d. Manufacturer specifications and data that clearly show that the process control network system cabling, cable accessories, patch panels, enclosures, and other items supplied meet all requirements specified herein.
e. Off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.
f. Recommended Spare Parts List (RSPL).
g. List of recommended special tools for cable installation testing or maintenance.

D. Operations and Maintenance Manuals

1. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

a. Description of all components.
b. Product data submittal.
c. Cable routing diagrams.
d. Connection diagram.
e. Test reports.
f. Maintenance and troubleshooting procedures.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All process control network cabling, hardware, and accessories shall be designed, assembled, and connected in accordance with the requirements of these Specifications and the Drawings.

B. Materials and Quality

1. Materials shall be new, free from defects, and of the quality specified. Parts shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

2. All process control network cables and equipment of each type shall be from the same manufacturer.

2.2 ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE

A. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be Cat 6 UTP cable. Cable shall be Cat-6 for network speeds greater than 100 MHz. Jacket color coding for cables shall be as follows:

1. Standard Cat-6 Process Control System Networks – Blue

2. Standard Cat-6 Security System Networks – Yellow

3. Standard Cat-6 Administrative/Enterprise Networks - White

4. Crossover cables - Red

B. Category 6 UTP Cable

1. Cat-6 UTP cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid copper conductor
c. 100 Ohm impedance
d. 1-250 MHz frequency range
e. Max attenuation 19.8dB @ 100 MHz
f. Min NEXT 45.3dB @ 100MHz
g. Min PS-NEXT 45.3dB @ 100MHz
h. Min ELFEXT 27.8dB @ 100MHz
i. Min PS-ELFEXT 24.8dB @ 100MHz
j. Min return loss 21.0dB @ 100 MHz
k. Max delay skew 25 ns
l. Max propagation delay 537.6 ns

2. Plenum rated cable shall have PVC insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene or polypropylene insulation for conductors. Cat-6 cable shall be Belden 2413 (plenum) and 2412 (non-plenum) or equal.

C. Ethernet Patch Cables

1. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require unterminated wire to be installed. Patch cables shall be Cat-6 for networks speeds greater than 100 MHz and shall meet the requirements of Cat-6 cable specified in this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3 (Ethernet Cable Installation). Crossover cables shall be wired using the T568-A standard for one connector and the T568-B standard for the opposite end.

2.3 PLC COMMUNICATIONS MEDIA

A. System Supplier shall provide all necessary cabling for the PLC communications network and PLC remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules.

2.4 ETHERNET CABLE TEST EQUIPMENT

A. One hand-held network cable tester that is compatible with the provided network cabling shall be provided. The cable tester shall check for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs for faults up to 100 m. Tester shall be Fluke MicroScanner Cable Verify, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

B. Cable Damage

1. If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed,

coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor's expense.

C. Ethernet Cable Installation

1. Straight through cables shall be wired using the latest version of T568 standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor
1 2	White/Green Green	White/Orange Orange
3 6	White/Orange Orange	White/Green Green
4 5	Blue White/Blue	Blue White/Blue
7 8	White/Brown Brown	White/Brown Brown

2. Shielded Cat-6 cabling shall be grounded on only one end of the cable.

3.2 CABLE TESTING

A. After the network cabling has been installed, each network cable shall be tested.

B. Test Equipment

1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

C. Ethernet UTP and STP Cable Testing

1. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP and STP cable installation. All test

equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.

D. Test Equipment and Materials

1. The following materials shall be submitted and approved prior to the start of cable testing.

   a. A list of test equipment which will be used during the course of the cable testing.
   b. The manufacturer's specification sheets for each item of test equipment.
   c. The proposed testing sequence, expected duration, and scheduled date proposed for testing.
   d. Blank copies of the test forms proposed including pass/fail criteria.

End of Section

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SECTION 40 66 34 - FIBER OPTIC COMMUNICATION CABLE AND EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of fiber optic cable systems to provide communications for the Process Control Network System as indicated on the Drawings.

B. Accessories and appurtenances shall be provided as specified herein and as required to provide a complete and properly operating system.

C. Equipment and services provided under this section shall be subject to the requirements specified in the Instrumentation and Control System section and the Process Control Network Systems section. Supplementing the Fiber Optic Communications Cable and Equipment section, network data, special requirements, and options are indicated on the Drawings.

D. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

E. The Work consists of providing all labor, services, materials, tools, equipment, and appurtenances necessary to furnish, install, test, and commission a complete fiber optic communications network.

1.2 QUALITY ASSURANCE.

A. General.

1. It is the intent of these Specifications and of the Drawings to establish quality standards of all equipment and materials and to require first class workmanship.

2. All equipment and materials shall be new, free of defects and of the highest quality. No existing or used equipment is allowed.

3. All work shall be accomplished by qualified, experienced personnel working under continuous and competent supervision.

4. The Contractor shall apply and install materials, equipment, and specialties in accordance with manufacturers' written instructions.

5. Fiber optic cable system work shall conform to the construction schedule and the progress of other trades.

B. Referenced Standards

1. This Section references the latest revisions of the following standards. They are part of this Section as specified and modified. These shall govern, as applicable, the terminology, design, materials, construction, and the testing methods for the equipment specified in this Section. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

Reference	Title
ANSI/IEEE Std. 100	IEEE Standard, Dictionary of General and Electronic Terms
Telcordia GR-20-CORE Issue 4	Generic Requirements for Optical Fiber and Optical Fiber Cable
ANSI/ICEA S-104-696-2013	Standard for Indoor-Outdoor Optical Fiber Cable
ANSI/CEA S-83-596	Standard for Optical Fiber Premises Distribution Cable
ANSI/CEA S-87-640	Standard for Optical Fiber Outside Plant Communications Cable
TIA/EIA 455	Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices
ITU-T G.651.1	Characteristics of a 50/125 μm Multimode Graded Index Optical Fibre Cable
TIA/EIA 492AAAA	Detail Specification for 62.5/125 μm Class Ia Graded-Index Multimode Optical Fibers (OM1)
TIA/EIA 492AAAB	Detail Specification for 50/125 μm Class Ia Graded-Index Multimode Optical Fibers (OM2)
TIA/EIA 492AAAC	Detail Specification for 850 nm Laser-Optimized, 50/125 μm Class Ia Graded-Index Multimode Optical Fibers (OM3)
TIA/EIA 492AAAD	Detail Specification for 850 nm Laser-Optimized, 50/125 μm Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber
TIA/EIA 492CAAA	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers (OS1)

Reference	Title
TIA/EIA 492CAAB	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak (OS2)
ITU-T G.651.1	Characteristics of a 50/125 μm Multimode Graded Index Optical Fibre Cable
ITU-T G.652.D	Characteristics of a Single-Mode Optical Fibre and Cable
IEC 60793-2-10 Type A1b	Product Specifications - Sectional Specification for Category A1b Multimode Fibres (OM1)
IEC 60793-2-10 Type A1a.1	Product Specifications - Sectional Specification for Category A1a.1 Multimode Fibres (OM2)
IEC 60793-2-10 Type A1a.2	Product Specifications - Sectional Specification for Category A1a.2 Multimode Fibres (OM3 and OM4)
IEC 60793-2-50 Type B1.3	Product Specifications - Sectional Specification for Class B Single-Mode Fibers
TIA/EIA-598-C	Optical Fiber Cable Color Coding
TIA/EIA 526-7	Optical Power Loss Measurements of Installed Single-Mode Fiber Cable Plant, Method A
TIA/EIA 568-C.0	Generic Telecommunications Cabling
TIA/EIA 568-C.3	Optical Fiber Cabling Components Standard
TIA/EIA-604-10A	Fiber Optic Connector Intermateability Standard, FOCIS-10 (Type LC)
TIA/EIA-606-C	Administration Standard for Telecommunications Infrastructure
NECA-301-2016	Standard for Installing and Testing Fiber Optic Cables
RoHS 2011/65/EU	Restriction On the Use of Hazardous Substances
TIA/EIA-606-B	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
Telcordia GR-TSY-356-CORE	Generic Requirements for Optical Cable Innerduct, Associated Conduit, and Accessories

Reference	Title
ANSI/SCTE 77	Specification for Underground Enclosures Integrity
UL 969	Standard for Marking and Labeling Systems

C. Codes and Regulations.

1. This Section references the latest revision of the following codes. They are a part of this Section as specified and modified. Apparent conflicts between the Contract Documents and the listed codes shall be submitted to the Owner for resolution prior to ordering materials or performing affected work.

1.3

Reference	Title
NEC	National Electrical Code (NFPA 70)
NESC	National Electrical Safety Code
UBC	Uniform Building Code

A. Measuring Equipment and Tools.

1. Validity of measurements and tests shall be ensured through the use of suitable inspection, measuring and test equipment of the range and type necessary to determine conformance of items with the Contract requirements. Measuring devices shall be verified or calibrated against certified standards that have a known traceable relationship to the National Bureau of Standards. Every device verified or calibrated shall bear an indication attesting to the current status and showing the date on which inspection or re-calibration is next required. Tests shall not be conducted using test equipment having an expired calibration date. Any tests run with instruments not in compliance with the requirements in this paragraph shall be considered invalid.

1.4 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

B. Qualifications

1. For projects that involve fiber optic cable installations, the name, address, and telephone number of the proposed contractor or subcontractor who will be installing the fiber optic cables, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and

telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

C. Drawings and Data

1. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

2. Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for proposed fiber optic cable, fiber patch panels, splice enclosures, splicing devices and materials, fiber optic cable accessories (pigtails, connectors, etc.), and other items supplied.
b. Information shall include materials of construction and complete ordering information.
c. Product information shall be neatly marked to indicate only those items, options, model, or series of equipment which are being submitted for approval. All extraneous materials shall be crossed out.
d. Manufacturer specifications and data that clearly show that the process control network system cabling, cable accessories, patch panels, enclosures, and other items supplied meet all requirements specified herein.
e. Physical dimension drawings of all fiber optic accessories.
f. Proposed fiber identification sequence and labeling.
g. Off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.
h. Recommended Spare Parts List (RSPL).
i. List of recommended special tools for cable installation testing or maintenance.

D. Fiber Optic Cable Pulling Work Plan

1. Submit for review and acceptance a Fiber Optic Cable Pulling Work Plan.

a. Contractor shall not perform installation of fiber optic cable and equipment without an approved Fiber Optic Cable Pulling Work Plan by the Engineer.
b. Submit for review the Fiber Optic Cable Pulling Work Plan a minimum of 30 business days prior to planned initiation of cable pulling.
c. Provide cabling pulling calculations for the entire run of each fiber optic cable.
d. The pulling plan and pull tension calculations may be prepared by using a software program such as Pull-Planner 3000 by American Polywater Corporation or approved equal.

2. Submit the following as a minimum.

a. Pull tension calculations.
b. Proposed pulling points and direction of pulls.
c. Pulling lengths and bending radius of conduits.

d. Detailed description of pull operation methods for all cable runs.
e. Tools and equipment to be used for cable installation.
f. Physical location of equipment setup and type.
g. Safety and manual assist cable pulling operations.
h. Calculated amount of lubricant required.
i. Detailed schedule for pulling cables.

E. Test Procedures

1. Submit for review and acceptance Fiber Optic Cable Test Procedures.

a. Contractor shall not perform testing of fiber optic cable and equipment without an Engineer approved Test Procedures for all cable and equipment furnished and installed.
b. Submit for review a detailed test procedure for each test activity defined in Part 3. No test shall be performed before the test procedure has been accepted by Engineer and Owner. If necessary, Contractor shall reschedule the test, at no additional cost to the Owner, so that this requirement is met.

2. For each test, submit a procedure test form that clearly identifies the following:

a. Test Number
b. Purpose of test: Describe what is being verified by this particular test.
c. Test Method: Describe the setup for the test and the steps required to complete the test. Provide forms and checklist to control and document the required tests.
d. Each step in the test procedures shall be numbered and each test shall include a space for Contractor and Owner to initial when the test is satisfactorily completed.
e. Criteria: Describe the criteria for passing or failing the test.
f. Provide a test schedule.
g. Provide a list of all test equipment to be used for the tests.
h. Submit test forms to record test results.

F. Test Reports

1. After completion of tests, submit for review and acceptance Fiber Optic Test Reports.

a. Develop, maintain, and update a Test Report for each test. This report shall include listings of all test deficiencies and their resolutions, system retesting requirements, and system design changes, if required, due to system testing, and verification for all tests required by this Section.
b. Submit the Test Report within five (5) business days after the completion of each required test. The Owner reserves the right to delay or suspend follow-on project activities if an acceptance test report has not been provided in the required time period.
c. Provide test results in printed and electronic format (native format for the application and in PDF format). Cover sheet shall include date of test and original signatures of test witnesses. Provide five (5) printed copies of all test reports.

G. Fiber Optic Cable System Records

1. Provide cable records and fiber assignments of the "as-built" condition of each cable, fiber, and each fiber patch panel. Documentation shall be provided in hard copy and on USB drive. Provide five (5) printed copies of fiber optic cable system records. At a minimum, the following shall be provided:

    a. Fiber optic cable routing and location information.
    b. Fiber connectivity information.
    c. Patch panel locations.
    d. Patch panel fiber termination data.
    e. Cable lengths.
    f. Cable part numbers.

H. Operations and Maintenance Manuals

1. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

    a. Description of all components.
    b. Product Data Submittal.
    c. Cable routing diagrams.
    d. Connection diagrams.
    e. Test Reports.
    f. Fiber Optic Cable Lengths Records.
    g. Fiber Optic Patch Panel Fiber Assignment Tables.
    h. Fiber Optic Jumper Cable Patch Records.
    i. Maintenance and troubleshooting procedures.

1.5 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1.6 QUALIFICATIONS

A. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the Contractor shall utilize personnel who are experienced in such practices. The installing Contractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2.1 GENERAL

A. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

B. Materials shall be new, free from defects, and of the quality specified. Parts shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

C. All fiber optic cables and equipment of each type shall be from the same manufacturer.

2.2 FIBER OPTIC CABLE

A. The fiber optic cable must meet all of the following common requirements:

1. Every fiber in the cable shall be usable and meet requirements of this Section.

2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this Section.

3. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

4. The storage temperature range for the cable on the original shipping reel shall be –40°C to +70°C. The operating temperature range shall be –40°C to +70°C. Testing shall be in accordance with FOTP-3.

5. The attenuation specification shall be a maximum attenuation for each fiber at 23 $\pm$ 5°C.

6. Each fiber shall be distinguishable from others by means of color coding in accordance with TIA/EIA-598-C, “Optical Fiber Cable Color Coding.”

7. The fibers shall be colored with ultraviolet (UV) curable inks.

8. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

9. The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g. “62.5/125 MICRON – TYPE OFNR – (UL) 00001 Feet”).

10. The cable shall be gel-free.

11. The cable manufacturer shall be TL 9000 Quality Management System certified.

12. Refer to the Drawings for number of fibers per cable.

B. NEC Requirements

1. All fiber optic cable shall meet the following requirements:

a. Fiber optic cable shall meet the requirements of the National Electrical Code (NEC) Section 770.
b. The cable jacket for all non-plenum cables shall be rated for indoor/outdoor use and shall meet the flame resistance rating requirements for NEC listed Type OFNR cable. Cables shall be constructed with polymer coated yarn that swells upon exposure to water thereby preventing intrusion of moisture into the cable.
c. The cable jacket for plenum cables shall meet the flame resistance rating requirements for NEC listed Type OFNP cable.
d. Riser Applications – Applicable Flame Test UL 1666.

C. OS2 Single mode Fiber

1. Singlemode fiber shall meet the following general requirements:

a. Environment: Indoor/Outdoor Cable
b. Cable Type: Loose Tube
c. Approved Cable Manufacturers: Belden, CommScope, Corning Cable Systems, AFL, Superior Essex, or approved equal.

2. Optical Specifications.

a. Singlemode optical fiber cable shall meet TIA/EIA 492-CAAB and Telcordia Generic Requirements GR-20-CORE and the following optical requirements:
1) Fiber type: Singlemode (OS2)
2) Fiber Category: G.652, Table D
3) Maximum Attenuation: 0.65 dB/km @ 1310 nm / 0.50 dB/km @ 1550 nm
4) Cladding Diameter (µm): 125.0 ± 0.7
5) Core Diameter (µm): 8.2
6) Core-to-Cladding Concentricity (µm): ≤ 0.5
7) Cladding Non-Circularity (%): ≤ 0.7
8) Point Discontinuity (dB): ≤ 0.05 @ 1310 nm / ≤ 0.05 @ 1550 nm

3. Cable Design.

a. Central Element: Dielectric
b. Fiber Coloring: Blue, Orange, Green, Brown, Slate, White, Red, Black, Yellow, Violet, Rose, Aqua
c. Outer Jacket Material: Flame Retardant, UV-Resistant
d. Armor: Corrugated Steel Tape.
e. Jacket(s): Dual
f. Outer Jacket Color: Black

g. Max. Tensile Strength, Short-Term: 2700 N (600 lbf)
h. Max. Tensile Strength, Long-Term: 8100 N (1800 lbf)
i. Min. Bending Radius (Installation): 270 mm (11 in)
j. Min. Bending Radius (Operation): 140 mm (5.5 in)

4. Cable Construction:

a. The central member shall consist of all dielectric material. The purpose of the central member is to provide tensile strength and prevent buckling.
b. The inner layer of the cable shall contain a water-swellable yarn or water-blocking element for water-blocking protection. The water-swellable yarn or water-blocking element shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. The yarn or element will preclude the need for other water-blocking material; the cable shall be gel-free.
c. Polyethylene jacketing material shall be applied directly over the interlocking armor. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
d. The cable jackets shall be free of holes, splits, and blisters.
e. The cable jackets shall contain no metal elements and shall be of a consistent thickness.
f. Cable jackets shall be marked with the manufacturer's name, month and year of manufacture, sequential foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code, fiber count, and fiber type. The actual length of the cable shall be within 1% of the length markings. The print color shall be white. The height of the marking shall be approximately 2.5 mm.
g. Corrugated steel armor shall run the length of the cable. (where specified in new Cable Schedule)

D. Fiber optic cable connectors

1. All optical fibers shall have connectors installed by one of the following two methods (mechanical or epoxy connectors are no longer allowed).

a. Preconnectorized Pigtail Cables.
1) Preconnectorized pigtail cables may be fusion spliced to the fibers from the fan-out kits.
2) Connector style, ST, SC, LC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable.
3) Preconnectorized pigtail cables shall be compatible with the supplied cable.
4) Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination.
5) Preconnectorized pigtail cables shall be Corning Cable Systems or equal.

b. Fusion Splice-On Connectors.
1) Fusion splice-on connectors may be fusion spliced to the fibers from the fan-out kits.

2) Connectors shall be installed using the appropriate tool kit manufactured by the same supplier as the connectors and in accordance with manufacturer's instructions.
3) Connector style, ST, SC, LC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable.
4) Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination.

E. Fiber Optic Jumper Cables

a. Fiber optic jumper cables with factory-terminated and tested connectors shall be furnished and installed for equipment interfacing and between termination cabinets. The jumpers shall meet the following requirements:
1) The jumpers shall be single mode (OS2) for operation at 1550 nm. They shall be tight-buffered and be protected by Kevlar-type strength material.
2) The jumpers shall be supplied with connectors on each end. Connector types (ST, SC, LC, etc.) shall be matched to the equipment provided. Jumpers shall be sized to provide a single connection between the fiber optic hardware being connected.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

B. Cable Damage

1. If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor's expense.

C. Fiber Optic Cable.

1. All fiber optic cable shall be installed, terminated, and tested by a qualified and approved fiber optic cable subcontractor. Coordinate the location of new fiber optic cables and equipment with the Owner based upon existing conditions at the project site including, but not limited to, actual routing of conduit duct banks, clearances, and locations of equipment. Minor changes in location of the material or equipment installed under this Contract from the locations shown on Contract Drawings shall be made at no cost to the Owner.

    a. Fiber Optic Cable Packaging, Handling, and Delivery
        1) Each cable shall be packaged for shipment on non-returnable wooden reels.
            a) Top and bottom ends of the cable shall be available for testing prior to removing cable from the reel.
            b) Both ends of the cable shall be sealed to prevent the ingress of moisture.
            c) Each cable reel shall be provided with all information necessary to positively trace the cable origin.
        2) Each cable reel shall have a weather resistant reel tag attached identifying the reel and cable and include the following information as a minimum:
            a) Cable number.
            b) Shipped cable length in feet.
            c) Manufacturer’s product number.
            d) Gross weight.
            e) Job order number.
            f) Customer order number.
            g) Date cable was tested in factory.
        3) One flange of each cable reel shall be marked with the following as a minimum:
            a) Cable manufacturer’s name.
            b) Country of origin
            c) An arrow indicating proper direction of roll when handling.
            d) Forklift handling illustration.
            e) “DO NOT SHIP REEL ON SIDE” or “DO NOT LAY REEL ON ITS SIDE”.
        4) Each cable shall be accompanied by a cable data sheet including the following information as a minimum:
            a) Cable number.
            b) Factory order number.
            c) Manufacturer’s product number.
            d) Customer cable number.
            e) Customer purchase order number.
            f) Ordered cable length in feet.
            g) Actual shipped cable length in feet.
            h) Measured attenuation of each fiber.
            i) Date cable was tested in factory.
        5) Care shall be taken to prevent damage to cable, equipment and material during delivery and storage.
        6) Upon receipt of each equipment item, the cable and equipment shall be visibly inspected for physical damage. No damaged equipment shall be

installed. All costs to replace and reinstall damaged equipment shall be borne by the Contractor.

7) Upon receipt of the fiber optic cable, the cable shall be visibly inspected for physical damage. The Contractor shall perform the Fiber Optic Cable Reel Test specified herein as soon as is practicable after cable delivery and prior to installation. Fiber optic cables not passing the Reel Test shall not be installed and shall be removed from the project site at no cost to the Owner.
8) Any damaged cable, equipment and material shall be removed from the project site and replaced at no additional cost to the Owner.
9) All cable handling and storage shall be performed in strict accordance with the manufacturer's recommendations.
10) During the installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect their finished and unfinished work against damage and loss. In the event of such damage or loss, they shall replace or repair such work at no cost to the Owner.

b. Fiber Optic Cable Installation

1) The installation of fiber optic cable and associated appurtenances shall be performed in strict accordance with the manufacturer's recommendations.
2) Contractor shall exclusively use fiber optic cable installers who have a minimum of three (3) years' experience installing and splicing fiber optic cables.
3) Prior to the installation of any cable or equipment, the Contractor shall review the conduit systems and equipment panels that will house the cable and equipment provided and installed under this Contract. The Contractor shall notify the Owner and Engineer in writing if any conflicts are identified in this regard prior to the purchase of any equipment.
4) Contractor shall plan the work and inform Owner and Engineer on a daily basis of the fiber optic cable installation work schedule.
5) Install fiber optic cable conduit per the requirements of the Electrical sections and the following requirements:
    a) The minimum bending radius for 2-inch fiber optic cable conduits shall be 24 inches. The minimum bending radius for 4-inch fiber optic cable conduits shall be 36 inches.
    b) The maximum number of degrees of conduit bends between fiber optic cable pulling points shall be 180 degrees. Furnish and install additional indoor pull boxes and outdoor handholes to meet this requirement.
    c) Furnish and install duct plugs where fiber optic cable conduits from buildings enter each hand hole. Furnish and install duct plugs where fiber optic cable conduit terminates in buildings. Duct plugs shall prevent the ingress of moisture and rodents.
    d) Seal all conduit and cabinet entrances with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.
    e) The maximum distance between pull boxes shall be 100ft. If conduit with fiber optic cable will run more than 100ft without pull box or handhole, a pull box shall be installed.

f) A prelubricated polyester tape with minimum strength of 600lbs shall be installed as pull string for future use in fiber optic conduits. Pull string shall be Neptco Muletape, with no exceptions.

6) Install fiber optic cables in accordance with NECA 301-2009, per the requirements of the Electrical sections.
7) During installation, care shall be taken not to bend the cable excessively. The bending radius shall not be less than 15 times the outside diameter of the cable or twelve (12) inches, whichever is greater. Minimum bend radius restrictions shall be satisfied both during and after cable installation.
8) The Fiber Optic Cable Pulling Work Plan shall be submitted and successfully reviewed in accordance with the submittal requirements in Part 1 prior to starting installation of fiber optic cable.
9) Do not exceed cable manufacturer's maximum tensile rating during cable installation by means of strain-release or other tension limiting devices.
10) No residual tension shall remain on cable after installation except that which is due to cable's weight in vertical rise.
11) Except for hand pulls, pulling tension shall be continuously monitored during cable installation.
12) Fiber cable shall be pulled in a steady continuous manner.
13) For vertical runs of fiber optic cable, the following requirements shall be followed:
    a) Secure vertical cable at top of run.
    b) Attachment point shall comply with cable's minimum bend radius.
    c) Provide intermediate support when manufacturer specified maximum cable rise has been reached.
    d) Support cable by Kellems, or equal, woven mesh grips.
14) Manufacturer approved clamps and supports shall be used to relieve stress on the fiber optic cable. Horizontal, unsupported cable runs shall be supported at continuous distances of 5 feet or less. The installation of fittings and clamps shall be performed using tools and procedures conforming to the manufacturer's recommendations.
15) Fiber optic cable shall be provided in continuous runs without mid-span splices.
16) A 25-foot (minimum) coil of additional unstripped cable in each fiber optic cable shall be provided in the vicinity of each cable termination point. Provide slack loops in pull boxes.
17) Fiber optic cable shall be protected at all times to prevent cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.
18) Cable routing within buildings and occupied office areas shall conform to Federal, State, and local electrical and fire codes.
19) Labels shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
20) Splice and terminate fiber optic cables in accordance with the following requirements:

a) Fiber optic cables shall be spliced and terminated in Fiber Patch Panel (FPP) at the terminal location of each cable as shown on the Drawings.
b) Mid-span splices are not allowed.
c) All fiber strands shall be spliced and terminated at both ends.
d) Splices shall be performed only by experienced personnel with proper equipment. The work area shall be arranged such that the area is kept clean, and the exposed cable is protected from physical damage.
e) Splice a factory connectorized fiber optic pigtail cable to each fiber in all fiber optic cables entering fiber patch panels.
f) All splices shall be fusion type splices.
g) Provide a minimum of 12 inches of spare fiber for each splice.
h) Splices shall not cause attenuation of signal exceeding allowable attenuation budget.
i) Measure the optical power loss as the splices are being made. Splices with an optical loss of greater than 0.2 dB shall be redone.
j) After splicing, the splice point shall be protected by the splice tray and placed into the terminating hardware. Splices shall be protected using heat shrink tubing and mechanical crimp protectors.
k) Fiber patch panel terminations shall be provided in pre-assembled housings that snap into the fiber patch panels.
l) Fiber patch panel connector modules shall be sized for a minimum of 12 fiber terminations.
m) After splicing, the connectorization point shall be protected and placed into terminating hardware.
n) Labeling shall conform to the requirements specified within ANSI/TIA/EIA-606-B or to the requirements specified by the Owner.

21) Install fiber patch panels as shown on the Drawings and as part of the Work specified in the Panels, Consoles, and Appurtenances section.
22) Furnish and install fiber optic patch (jumper) cables as shown on the Drawings. Cap unused patch panel ports.
23) Ground the armor on armored fiber optic cables in accordance with manufacturer's recommendations.

3.2 CABLE TESTING

A. After the network cabling has been installed, each network cable shall be tested.

B. Test Equipment

1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

C. Fiber Optic Cable Testing

1. Prior to acceptance of the system by the Owner, the completed fiber optic cabling system including all splices, terminations, and connections shall be tested to demonstrate that all

cables and devices furnished, installed, and/or connected under the provisions of these Specifications function in the manner required.

a. The Contractor shall not proceed with a test unless the corresponding test procedures have been submitted and received a favorable submittal review.
b. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification, and administration of the work called for in the Contract Documents.
c. Test fiber optic cables in accordance with NECA 301-2009.
d. Fiber testing shall be performed on all fibers in each cable.
e. If any test requirement is not met, the Contractor shall take immediate steps to identify the cause of the condition. When the cause is identified, notify the Owner and Engineer in writing of its nature and provide a description of the proposed method or procedure to rectify the problem.
f. Field testing shall be witnessed by the Owner and Engineer.
g. Owner and Engineer shall be notified of the start date of each test a minimum of five (5) business days before testing commences.
h. Owner may conduct a parallel random sample test of 5% of the installed links at Owner's expense. The results obtained will be compared to the data provided by the Contractor. If more than 2% of the parallel test results differ in terms of the pass/fail determination, Contractor shall repeat 100% testing at no cost to the Owner.

D. Test Preparation

1. In preparation of each test, conduct the following work:

a. Provide test jumpers of the same core size and connector type as the cable system.
b. Stabilize optical sources at 1310 nm and at 1550 nm for single-mode fiber and 850 nm and 1300 nm for multimode fiber.
c. Calibrate the power meter at each of the nominal test wavelengths.
d. Properly clean connectors, adapters, and jumpers prior to measurement.

E. Test Equipment and Materials

1. The following materials shall be submitted and approved prior ro the start of cable testing:

a. A list of test equipment which will be used during the course of the cable testing.
b. The manufacturer's specification sheets for each item of test equipment.
c. The proposed testing sequence, expected duration and scheduled date proposed for testing.
d. Blank copies of the test forms proposed including pass/fail criteria.
e. A list of personnel who will conduct the fiber testing, and a summary of their qualifications.

F. Test Personnel

1. Testing shall be conducted only by technicians who have successfully attended an appropriate training program including, at a minimum, training with an optical time domain reflectometer and optical loss test sets and have obtained a certificate as proof thereof. Furnish proof of the certification of all test personnel. These certificates may have been issued by any of the following organizations or an equivalent organization.

    a. Training organizations including BICSI, a Telecommunications Association, Association of Cabling Professionals (ACP), or approved equivalent.
    b. Manufacturer of the test equipment used for the field testing of the fiber optic cable system.
    c. Manufacturer of the fiber optic cable.

G. Fiber Optic Cable Reel Test

1. The Fiber Optic Cable Reel Test (Reel Test) is a preliminary test performed after cable has been delivered to the project site and prior to installation. This test shall be performed as soon as practicable after receipt of the shipment. The Reel Test only requires one end of the cable and does not require connectors on the fiber. The Reel Test shall verify that the fiber is received from the shipper in sound condition and without manufacturing defects. Any anomalies shall be reported immediately to the shipper and manufacturer. Cable shall not be installed until it passes this test.

    a. Reel Test Requirements. Record the following information:
        1) Cable ID.
        2) Cable type.
        3) Number of fibers.
        4) Cable length as shown on reel.
        5) Maximum specified loss at 850 nm and 1300 nm for multimode fiber.
        6) Maximum specified loss at 1310 nm and 1550 nm for single-mode fiber.
        7) Date.
        8) Test crew names.
        9) OTDR model and serial number.

    b. Inspect the cable and record any visible signs of defects and damage. Damaged cables shall not be installed.
    c. Strip at least two feet of the cable end. Clean and strip the fibers.
    d. Use a bare fiber adapter and an OTDR to take the following measurements from one end of the cable.
        1) Total loss at 850 nm for multimode fiber or 1310 nm for single-mode fiber.
        2) Attenuation per 1000 feet at 850 nm or 1310 nm, per cable type.
        3) Total loss at 1300 nm for multimode fiber or 1550 nm for single-mode fiber.
        4) Attenuation per 1000 feet at 1300 nm or 1550 nm, per cable type.
        5) Total length as indicated by ODTR.
        6) Note any anomalies (rescale for clarity and record).
        7) Date.
        8) Test crew names.
        9) OTDR model and serial number.

e. Print and record the OTDR traces on disk. Indicate direction of measurement, and fiber color.
f. Note differences between the 850 (1310) nm trace and the 1300 (1550) nm trace.
   1) Uncut cable shall have no reflections or attenuation steps.
   2) Attenuation steps or gains at both wavelengths indicate spliced, broken, or damaged fiber.
   3) Reflections indicate broken fiber.
   4) Compare the test results to the manufacturer's specifications.
   5) Remove bare fiber adapter and cut off excess fiber from the cable end.
   6) Note any anomalies (rescale for clarity and record).
   7) Install heat shrink or other protective covering to the cable end to prevent the entry of moisture or other contaminants.
   8) Test crew names.
   9) OTDR model and serial number.

g. Attenuation for any fiber exceeding 5% of data provided in the shipping records shall be cause for rejection of the entire reel.
h. Failure of a single fiber in a cable shall be cause for rejection of the entire reel.
i. Reels of cable that fail to meet the requirements of the Reel Test shall be replaced at no cost to the Owner.

H. Magnified Endface Inspection and Record

1. Inspect and record the endface of each fiber strand prior to terminating or splicing the fiber.

   a. The endface of each fiber shall be inspected for endface quality at a magnification of 400X.
   b. Scratched, pitted, or dirty connectors shall be corrected.
   c. Endface images shall be recorded in the memory of the test instrument for subsequent uploading to a computer and reporting in PDF file format.

I. Splice Loss Test

1. Test and document the splice loss for each fiber strand for each pigtail assembly during cable termination at patch panels. Submit the documentation for this testing as part of this test procedure. Measurements shall be made at both 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber. No splice shall have a loss of 0.2 dB or greater.

2. Splice Loss Test Report

   a. Submit completed test sheets as part of the test report on the splice loss measurement. The sheets shall include the following.
      1) Project identification and facility location.
      2) Test date.
      3) Make, model and serial number of the test equipment.
      4) Cable identifiers.
      5) Fiber identifiers and color.

6) Terminal test location.
7) Wavelength.
8) Splice Loss.
9) The signatures of the splicer and all witnesses.

J. Fiber Continuity and Length Determinations

1. Measure the fiber optic continuity and length of each fiber with an optical power meter or OTDR after fibers have been terminated. Measurements shall be made at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber in both directions along each fiber.

2. Fiber Continuity and Length Determinations Report

a. Submit fiber continuity and length test documentation for each fiber as tested in both directions. The documentation shall include the following.
1) Project identification and facility location.
2) Test date.
3) Make, model and serial number of the test equipment.
4) Cable ID.
5) Fiber ID and color.
6) Terminal test location.
7) Test wavelengths.
8) Length and verification of continuity for each fiber strand.
9) Acceptability of all cables (i.e. pass/fail)
10) The signatures of test personnel and all witnesses.

K. OTDR Test

1. The end-to-end optical quality of each fiber shall be tested per TIA/EIA 455 after all fibers in each cable are spliced and terminated at the patch panels. OTDR traces shall be created and submitted for each fiber.

2. A launch cable shall be installed between the OTDR and the first link connection. Testing of the cabling shall be performed using high quality test cords of the same fiber type as the cabling being tested.

3. Measurements shall be made at both 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber in both directions along each fiber. To be accepted, each fiber shall show on the OTDR trace as a continuous span free from transmission anomalies, uniformity of cable attenuation and connector insertion loss. OTDR traces shall show no signs of abnormal characteristics when compared to the traces performed by the manufacturer prior to shipment.

4. OTDR Test Criteria

a. Each cabling link shall meet or exceed the following OTDR test requirements.
1) Reflective events (connections) shall not exceed 0.75 dB.
2) Non-Reflective events (splices) shall not exceed 0.30 dB.

5. OTDR Test Report

a. Submit fiber quality test documentation for each fiber strand as tested in both directions. The documentation shall include the following.
1) Project identification and facility location.
2) Test date.
3) Make, model and serial number of the test equipment.
4) Cable ID and type.
5) Fiber ID and color.
6) Test terminal locations.
7) Wavelength.
8) Optical return loss (ORL in dB) at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber.
9) OTDR traces and acceptability of all fiber strands (i.e. pass/fail) at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber.
10) The signatures of test personnel and all witnesses.

L. Optical Loss Test

1. Testing shall consist of an end-to-end optical power meter test performed in accordance with TIA/EIA 526-7. Provide optical power loss measurements at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber. Measure the optical power loss for each fiber. Use a stabilized light source and an optical power meter for the test. Establish and measure the reference power receive level using a patch cord and connectors of the same types used on the full cable. Care shall be taken to provide an exact match of connectors and mating hardware used in the reference measurement so that the same setup losses are reproduced when measuring the full cable. Do not turn off the LED or laser source at any time during the testing. Properly clean all connectors.

2. Optical Loss Test Criteria

a. The measured optical power loss for each end-to-end fiber link shall be less than or equal to the maximum allowable loss calculated using the equation below. The terminal locations of end-to-end links are the ports in the fiber patch panels.

$$PL = Ns(Ls) + 2(Lc) + (La)(Length) + 0.5$$

Where PL = Optical power loss, maximum allowable
Ns = Number of slices in end-to-end link
Ls = Loss per splice (0.2 dB)
Lc = Loss per connector (0.3 dB)
La = MM optical power attenuation at 850 nm (3.0 dB/km)
La = MM optical power attenuation at 1300 nm (1.0 dB/km)
La = SM optical power attenuation at 1310 nm (0.65 dB/km)
La = SM optical power attenuation at 1550 nm (0.50 dB/km)
Length = Fiber length (km)

3. Optical Loss Test Report

    a. Submit fiber test documentation for each fiber strand. The documentation shall include the following.
        1) Project identification and facility location.
        2) Test date.
        3) Make, model and serial number of the test equipment.
        4) Cable ID and type.
        5) Fiber ID and color.
        6) Test terminal locations.
        7) Wavelength.
        8) Span length.
        9) Maximum allowable optical power loss for each end-to-end link at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber.
        10) Measured optical power loss for each end-to-end link (per strand) at 850 nm and 1300 nm wavelengths for multimode fiber, and 1310 nm and 1550 nm wavelengths for single-mode fiber.
        11) Acceptability of all fiber strands (i.e. pass/fail).
        12) The signatures of test personnel and all witnesses.

4. Fiber Optic Patch Cable Test

    a. Each fiber optic patch cable shall be tested and must exhibit an end-to-end attenuation of less than 2.0 dB at 850 nm for multimode fiber and 1310 nm for single-mode fiber. Any jumper exceeding this attenuation shall be replaced at no additional cost to the Owner. Submit test documentation for fiber optic patch cord test results.

M. Compliance

1. Any fiber optic cable not meeting the testing requirements of this Section shall be brought into compliance by the Contractor at no additional cost to the Owner.

2. Failed Test Correction Requirements

    a. Any link that fails the test requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation as specified herein.

3. Failed Test Replacement Requirement

    a. Any fiber optic cable containing one or more fibers not meeting the testing requirements will not be accepted by the Owner and shall be replaced and retested at no additional cost to the Owner.

4. Broken Strand Correction Requirement

a. If one (1) or more pairs of strands for a fiber optic cable is found to be broken the entire cable shall be removed, and a new cable shall be installed at no additional cost to Owner.

3.3 INSPECTION

A. After the completion of installation and testing, a walkthrough shall be performed to verify the Contract requirements are complete. The inspection will be conducted by the Owner and/or Engineer in the presence of the Contractor. The inspection shall be performed at a time agreeable to all parties.

B. Final Inspection Checklist

1. The final inspection checklist shall include, but not be limited to the following.

a. Fiber cable terminations shall be neatly dressed and organized in fiber patch panels.
b. Fiber splices at terminal panels shall be neatly organized in splice trays.
c. All connectors and unused patch panel ports shall be capped and undamaged.
d. All cables shall be properly identified. Install directories in each fiber termination and patch panel.
e. Fiber optic cables in handholes shall be neatly dressed.
f. Fiber optic conduits shall be sealed as specified.
g. All cabling shall be installed with no excessive bending.
h. Verify unused cable has been delivered to the Owner.

C. Punchlist

1. Discrepancies found during the inspection of the fiber installation shall be listed and provided to the Contractor in the form of a punchlist. Correct all punchlist items at no increase in Contract time or Contract cost. Inform the Owner and/or Engineer upon completion of the punchlist items.

3.4 COMPLETION OF WORK

A. At the completion of the Work, remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

3.5 WARRANTY

A. The fiber optic cable system, including all cable, splices, connectors, fiber termination panels and other connecting hardware, shall be warranted to be free from defects in material or faulty workmanship for a period of three (3) years from acceptance of the system by the Owner.

End of Section

SECTION 40 66 53 - RADIO EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of radio communication equipment for the Instrumentation and Control System. Radio equipment shall operate in conjunction with field devices such as PLCs, RTUs, DCUs, etc., as described elsewhere in these Specifications. The radio system shall consist of one remote radio located at the Wastewater Treatment Plant (COMM-4000).

B. The remote radio (COMM-4000) shall communicate with the Master Radio (COMM-3000) at the raw water intake facility.

C. Control System

1. The Instrumentation and Control System section shall apply to all equipment furnished under this section. Radio equipment shall interface with the Plant Control System (PCS) via Ethernet connections and operate as a transparent communication link between sites.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. Supplementing this section, the Drawings show the configuration of the radio system, a location map of the sites, and antenna types with support and cable and mounting details. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the Drawings.

D. Accessories

1. System Supplier shall provide all necessary equipment such as channel processors, line buffers, communication couplers, and modems, to transmit commands and receive data

via communication channels. System Supplier shall also provide all radio transmitters, receivers, antennas, cabling, and mounting hardware for a complete operational radio system.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage, and shipping shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Radios and accessories shall be suitable for installation in enclosures and for environmental conditions as follows:

Radio Type	Tag	Enclosure	Service Conditions
Point-to-Point, Remote Radio	COMM-4000 (WWTP)	Mounted within Chemical building Local Control panel (LCP-4000) with other equipment's	Indoor, climate controlled environment

2.2 MAS RADIO

A. MAS Radio General Characteristics

1. The radio system shall consist of GE MDS industrial radio configured for ethernet based communication.

2. One remote radio (COMM-4000) shall be provided at the wastewater Intake.

3. The remote radio (point-to-point) shall communicate with the Master radio (Point-to-Multipoint).

4. Radio shall be suitable for continuous industrial operation and shall be compatible with integration into the SCADA/PCS system.

B. Communication Channel

1. Radios shall utilize radio frequency communication to provide reliable wireless communication links between the Raw water intake and the Wastewater treatment plant. The system shall include master radio COMM-3000 and remote radio COMM-4000.

2. The radio system shall support Ethernet communications and operate as a transparent communication link for the SCADA system.

C. System Equipment

1. MAS radio transceivers shall be the GE MDS series or approved equal.

D. Physical Interfaces

1. Physical interfaces shall be the following interfaces on the radio:

a. RJ45 ethernet
b. 50-ohm female antenna interfaces

E. Power Requirements

1. The MAS radio shall be designed for continuous operation on a nominal 24 VDC source.

2. All power wiring, terminations, and protection devices required for proper operation shall be provided. Radios shall be suitable for continuous operation in industrial environment.

2.3 SURGE SUPPRESSION

A. System Supplier shall provide an in-line RF surge suppressors on all antenna coaxial cable at each radio location to protect radio equipment from lightning and transient voltages. Surge suppressors shall be Polyphaser Series IS-B50LN-C2 or equal.

B. Two lengths of super flexible Heliax cable shall be supplied for each surge suppressor: one for the connection between surge suppressor and radio antenna port, and one for the connection between the coaxial transmission cable (1/2 inch and larger) and the antenna. The cable shall be terminated with standard N type connectors. The cable shall be Heliax 1/4-inch Type FSS1-50A.

C. Surge suppressors shall be properly grounded to the SCADA panel grounding system in accordance with the drawings and applicable codes. All hardware required for installation, including connectors and mounting provisions, shall be provided by the system supplier.

2.4 ANTENNA CABLE

A. All cabling between antennas and radio transceivers shall utilize a splice-free foam dielectric coaxial cable cut to length. Foam dielectric coaxial cable shall consist of an inner conductor surrounded by a foam dielectric, a corrugated outer conductor surrounding the dielectric, and a

polyethylene jacket. The installation shall use self-flaring connectors specifically designed for use with the cable. The antenna cable shall be grounded as indicated in the Drawings.

B. All foam dielectric coaxial cable for all antenna locations shall be ½-inch Heliax, "Type LDF4-50A.

C. All coaxial cable installations shall be properly supported, routed and weatherproofed. Cable shall be grounded in accordance with the applicable electrical codes. All materials and installation practices shall be suitable for reliable long term outdoor operations.

2.5 ANTENNAS

A. System Supplier shall furnish the antennas and supporting structures at radio sites as indicated on the Drawings. Antennas shall have an S/N (flat weighing) 15 dBm threshold at antenna port (3 kHz channel) of -104 dBm S/N for FM – digital.

B. Directional Antennas

1. A 10 dB directional Yagi antenna with a minimum 20 dB front-to-back ratio shall be provided for each remote transceiver radio site and polling remote radio site as indicated on the Drawings. Each antenna shall be of heavy-duty design for permanent installation, with gold anodized aluminum support boom and elements and mounting hardware supplied by the antenna manufacturer. The radiating element of the antenna shall be radome protected. Yagi antennas shall be Decibel DB498 or equal.

2. Antennas shall be suitable for outdoor installation and shall be compatible with the operating frequency off the radio system. Antennas shall be suitable for reliable communication between the Raw water intake and the Wastewater treatment facility. Antennas shall include all required mounting hardware and shall be compatible with the specified coaxial cable and connectors.

C. Grounding Conductors

1. All ground conductors shall be soft drawn copper cable or bar, not smaller than 12 AWG, bare or green insulated in accordance with the National Electrical Code.

2. Grounding shall be provided for radio equipment, coaxial cable, and surge suppression devices in accordance with the drawings. All grounding connections shall be made to the SCADA panel grounding system and shall ensure a continuous and low-resistance path to ground.

D. Ground Rods

1. Ground rods not described elsewhere shall be 5/8-inch diameter by 8 feet long, with a copper jacket bonded to a steel core.

2. Ground rods shall be installed at antenna locations and shall be bonded to the antenna system, coaxial cable shielding, and surge suppression devices as indicated on the

drawings. All grounding installations shall comply with the national Electrical Code and applicable local standards.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. General installation requirements are described in the Instrumentation and Control System section.

B. Radio Equipment

1. The radio equipment shall be mounted in field device enclosures or in a separate enclosure as specified herein. Separate enclosures shall be furnished with the same NEMA rating and color as the field device enclosure.

C. Radio Signal Strength Testing

1. See Appendix A for path study analysis. The results of that study are included as an appendix to these Specifications.

D. Functional Testing

1. As a minimum, the following functional tests shall be performed on the communications equipment.

a. Antenna Alignment
   1) After each antenna is permanently installed, a power monitor shall be used to properly adjust the antenna's horizontal and vertical azimuths for maximum signal strength. A written report on the monitoring results shall be submitted to the Engineer for review before the radios are placed into permanent operation.

b. FCC Radio License Check
   1) After each radio has been installed but before it is placed into permanent operation, verification of the correct center frequency and channel width according to the FCC license is required. Documentation of this check shall be submitted to the Engineer for acceptance.
   2) Because the FCC allows only 18 months for construction, System Supplier shall have at least four remote transceiver radios operational and communicating with a base radio or a repeater radio by the date as specified.

E. Surge Suppressor Installation

1. Surge suppressors shall be bulkhead mounted on the radio enclosures and shall be suitable for the sizes of cable inside and outside the enclosures.

F. Installation of Grounding Materials

1. Electrical system grounding and equipment grounding shall follow the National Electrical Code.

G. Antenna Installation

1. System Supplier shall provide and supervise the installation of antenna equipment at radio sites as indicated on the Drawings. Damage to tanks or reservoirs caused by the Contractor shall be repaired to the Owner's satisfaction at Contractor's expense.

End of Section

40 66 53 – Appendix A

40 66 53 – Appendix B

MAS RADIO PHYSICAL TESTING PROCEDURES
EXPLANATION OF TESTING PROCEDURES & ANALYSIS

This appendix describes the physical path radio testing procedure and the calculations used for the results indicated in Appendix A.

1.0 Background

Physical testing was conducted to verify availability of radio paths between the sites indicated in Appendix A. A unity gain antenna was mounted as indicated in Appendix A.

Testing was conducted using a MDS 1000u transceiver continuously keyed at the master radio site. This radio transmitted via 60 feet of feed line and the omnidirectional antenna mounted at the height stated above. Received signal strength was measured at each remote site using a MDS 2310A transceiver, a hand-held communication terminal, 30 feet of feed line, and a Yagi antenna.

Equipment used for physical path testing is listed in Table 1. The table provides specific data on each piece of equipment and the corresponding power loss or gain associated with each device.

2.0 Testing Procedure

Following is a description of the standard radio physical testing procedure used to determine the received signal strength. Received signal strength is measured at the remote radio antenna port for each remote site being tested.

2.01 Master/Repeater Site Testing

A unity gain omnidirectional antenna was securely mounted at the height and location listed in the background section herein. The antenna was connected to a MDS 1000u transceiver converted by Microwave Data Systems to transmit at a synthesized frequency in the 952 MHz range. Sixty feet of Belden 8237 coaxial cable was used as feed line between the omnidirectional antenna and the radio.

An MDS hand-held diagnostics terminal was used to verify that the radio transmission power was 5 watts, and that the transmitter was tuned to an available frequency as determined by frequency coordination studies. Before leaving the master radio location, transmission of the radio signal out of the omnidirectional antenna was verified by checking receive signal strength on a MDS 3910 transceiver radio tuned to the correct frequency.

2.02 Remote Site Testing

Remote testing was conducted using the configuration shown in Figure 1 and the equipment listed in Table 1. Upon arriving at testing site, the vehicle transporting the testing equipment was parked at the location where the remote Yagi antenna will be mounted, as shown in the Drawings. Testing was conducted with a Yagi antenna mounted on 10 feet of mast unless otherwise stated in the "Comments" column of Appendix A. A hand-held MDS terminal was connected to the MDS 2310A radio transceiver to verify that the receive frequency was correct, and to display receive signal strength of the radio signal at the antenna port of the MDS 2310A radio. Radio signal strength was measured from at least three locations within a 20 foot radius of the antenna mounting location. This was done to confirm that a

receive signal strength measured at a remote site is stable and free of reflections. The "Tested Signal Strength" is recorded in Appendix A.

Comments about the remote site testing are listed in the "Physical MAS Radio Signal Strength Test Results" as discussed above. These notes reflect variations in mast height of the Yagi antenna, conditions affecting the remote signal test (such as "Antenna always pointed at trees"), or final installation notes for inclusion in the design of the radio system as shown herein.

TABLE 1 - PHYSICAL RADIO PATH TESTING EQUIPMENT

Equipment Description	Manufacturer	Catalog Number	Gain/Loss
Omnidirectional Antenna, 806-960 MHz	Kathrein	K751161	0 dBd Gain
60' RG8 Coax with N Connectors	Belden	8237	4.98 dB Loss
Radio Transceiver Configured To Operate As A Master Station	Microwave Data Systems	MDS 1000u modified	Transmit 37 dBm
13.8 Volt 3 Amp DC Regulated Power Supply	Tripp Lite	PR-3a	NA
Yagi Antenna, 806-960 MHz	Maxrad	MYA 9306	8.5 dBd Gain
30' RG-213/U Coax with N Connectors	Belden	8267	2.63 dB Loss
Radio Transceiver	Microwave Data Systems	MDS 2310A	Minimum Receive Strength -117 dBm
20 foot mast in 5 foot sections	NA	NA	NA

3.0 Evaluation of Signal Strength Values

The tested signal strength received at a remote site is specific to the equipment used during testing. For this reason, the actual radio signal pathloss between a master/repeater site is calculated using measured signal strength values and equipment losses and gains as listed in Table 1. The following algorithm was used to calculate "Pathloss (dB)" as listed in Appendix A.

Equation 3-1: $P_r=P_t-C_{Lt}+G_t-P_L+G_r-C_{Lr}$

where;

P_r= Signal strength received = Measured dB

P_t= Signal power transmitted = 36.99 dBm

C_{Lt}= Feed line loss at transmitter = 4.98 dB

G_t= Gain of transmitting antenna = 0 dBd

G_r= Gain of receiving antenna = 8.5 dBd

C_{Lr}= Feed line loss at receiver = 2.63 dB

P_L= Pathloss (dB)

Therefore solving for P_L;

Equation 3-2: $P_L(dB)= 37.88-P_r(dBm)$

Equation 3-2 provides the actual pathloss. This value is used to calculate the fade margin from the minimum receive signal sensitivity of a MDS 2310A transceiver. The calculation for fade margin uses the final installation equipment gains and losses as specified herein. In the specific case of feed line loss between a radio and antenna, a loss of 3 dB is used. This is the standard maximum cable loss allowed by a Black & Veatch design; therefore all feed line for a project is sized to produce a loss less than 3 dB per radio to antenna connection. The algorithm used to calculate "Fade Margin" as listed in Appendix A.

Equation 3-3: $P_r = P_t-C_{Lt}+G_t-P_L+G_r-C_{Lr}-M$

where;

P_r= Minimum signal strength for a MDS 3910 transceiver = -117 dB

P_t= Signal power transmitted by a MDS 2100 repeater radio = 36.99 dBm

C_{Lt}= Maximum Feed line loss allowed at transmitter = 3 dB

G_t = Gain of transmitting antenna = 9 dBd

G_r= Gain of receiving antenna = 9 dBd

C_{Lr} = Maximum feed line loss allowed at receiver = 3 dB

P_L= Pathloss (dB) = Calculated M = Fade Margin (dB)

Therefore, solving for M:

Equation 3-4: $M = 128.11 + P_r$ (dBm)

4.0 Determination of Acceptable Path

It is Engineer's standard that a radio path must allow a minimum fade margin of 20 dB after final installation. A 20 dB fade margin should allow for reliable communications (99 percent availability) under changing conditions. This standard balances reliability and economic considerations for multiple address systems.

SECTION 40 67 11 - PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of panels, consoles, and appurtenances as indicated on the Drawings and listed in the attached Equipment Schedules 40 67 11-S01, 40 67 11-S02.

B. This section also describes requirements for panels furnished under other sections whose respective specification refers to this section. Panels furnished under other sections are not listed in the attached Equipment Schedules.

C. This section also covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

D. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

E. Control System

1. The Instrumentation and Control System section shall apply to all equipment furnished under the Panels, Consoles and Appurtenances section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the Drawings, specifications, equipment schedules, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Panel mounted instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

C. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For

"smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

F. Drawings

1. General dimensions and arrangements are indicated on the Drawings and on the attached equipment schedules. System Supplier shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

B. Meterolical and Seismic Compliance

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage and shipping shall be as per the Instrumentation and Control System section.

1.5 SPARE PARTS

A. Spare parts shall be provided as specified below.

Spare parts	Quantity
Power supply	1 of each type
Relay	1 of each type
Fuses	5 of each type

PART 2 - PRODUCTS.

2.1 PANEL DESIGN AND FABRICATION FEATURES

A. All panels furnished shall conform to the stipulations of NEMA ICS-6-1993 (R2001, R2006, R2011, R2016). Unless indicated otherwise on the Drawings, the following paragraphs describe general fabrication specifications for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.

B. Piping

1. Pneumatic tubing shall be 1/4-inch OD, soft annealed copper with compression fittings. Tubing and fittings shall be as specified in the Miscellaneous Piping section.

2. Fittings

a. Compression type bulkhead fittings shall be provided near the bottom or the top of the panel for all field connections. Compression nuts and sleeves shall be provided for the field connections. Indicators, recorders, controllers, and other pneumatic devices shall be provided with plugged test connections and shutoff valves for isolation.

3. Valves

a. All devices shall have separate air supply shutoff valves. Valves and compression fittings shall be as manufactured by Nupro, Parker Hannifin, Swagelock, Tylok, or Whitey.

C. Power Entrance

1. The power entrance to each panel shall be provided with a surge protection device. Refer to the Instrumentation and Controls section for surge suppression requirements.

D. Power Wiring

1. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 14 AWG. Wiring for ac power distribution, dc power distribution, intrinsically safe, and control circuits shall have different colors and shall agree with the color-coding legend on System Supplier’s panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 90°C.

E. Instrument and Control Wiring

1. All internal panel wiring shall be type MTW stranded copper wiring rated not less than 600 volts. Electronic analog circuits shall be twisted and shielded pairs rated not less than

300 volts. Analog circuits shall be separated from ac power circuits. Intrinsically safe circuits shall be physically separated from other circuits in accordance with applicable codes. Wires within the panel shall conform to the minimum size as shown in the table below.

Type	Minimum Wire Size	Color
AC Control	16 AWG	Red
DC Control	16 AWG	Blue
Analog Circuits	18 AWG Twisted Pair	Yellow

2. All wiring shall be grouped or cabled and firmly supported inside the panel. Each individual wire in power, control, and instrumentation circuits shall be provided with identification markers at each point of termination. The wire markers shall be positioned to be readily visible for inspection and the identification numbers shall match the identification on the supplier's panel wiring drawings. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

F. Terminal Blocks

1. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

G. Device Tag Numbering System

1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedule and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be permitted.

H. Nameplates

1. Nameplates shall be provided on the face of the panel or on the individual device. Panel nameplates shall have legends and approximate dimensions as indicated on the Drawings

and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.

I. Indicating Light Color Designations

1. Indicating lights shall be colored as shown in the following table unless indicated otherwise on the Drawings, in other specification sections, or in the instrument device schedule.

Color	Meaning
Red	Associated equipment or device is “running,” “open,” or is in an “unsafe” state or position
Green	Associated equipment or device is “stopped,” “closed,” or is in a “safe” state or position
Yellow or Amber	Associated equipment or device has “failed” or a process alarm condition is present or imminent.
White	All other conditions not defined above.

J. Painting

1. Interior and exterior surfaces of all carbon-steel panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer’s standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer’s standard coating. Finish coats shall have a dry film thickness of at least 4 mils. Color shall be ANSI 61 Gray. One quart of touch-up paint shall be furnished with the panels.

K. Factory Test

1. Panels shall be factory tested by the panel fabricator before shipment.

2.2 FREESTANDING VERTICAL PANELS

A. The following paragraphs specify the freestanding vertical panels:

1. Construction

a. Panel construction shall be an indoor, dusttight, completely enclosed cubicle formed from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch diameter holes at 12 inch centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be

ground smooth. Suitable lifting facilities shall be provided for handling and shipment.

2. Structure

   a. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage or heavier carbon steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors. Doors shall not be greater than 24 inches wide or spaced not greater than 36 inches center to center. Rear access doors shall be fabricated from USS 14 gage or heavier carbon steel.

3. Panel Front

   a. The front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

4. Doors

   a. Doors shall be essentially full height, having turned back edges and additional bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets.

5. Mounted Instruments

   a. The front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch carbon steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections, Panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.
   b. Instrument Arrangement
      1) Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet and 5’-9” above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet and 2’-6” above the base of the panel. Indicators may be located within 2’-6” and 6’-6” above the base of the panels. Annunciators and clocks may be mounted near the top of the panels.

6. Conduit Entrance

a. The bottom shall be open, and components shall be arranged for external wiring conduit and piping to enter from below.

7. Size and Arrangement

a. Panel dimensions and general instrument arrangement shall be as indicated on the Drawings or in the attached equipment schedules.

8. Interior Lighting

a. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6" and near the door. Fixtures shall be minimum 400 lumen LED type, with a common "On-Off" switch near each end door. Duplex-grounded receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2.3 FIBER OPTIC PATCH PANELS

A. Fiber optic patch panels (also referred to as fiber termination cabinets) shall be furnished to terminate fibers at the fiber optic modules, and any other data highway attached equipment. The cabinets shall meet the following requirements:

1. The patch panels shall be the wall and rack mounted type, having provisions for terminating multiple fiber optic cables. Splice trays, strain relief cable attachment points, fiber organizers and bend radius hardware shall be furnished with each termination cabinet.

2. Panel size shall be suited to the number of fibers to be terminated within the cabinet. Bayonet/flanged couplings shall be furnished and mounted for each fiber to be terminated.

3. Fiber terminations shall be spliced to pigtail cables (specified below) having LC connectors. The pigtails shall be terminated in an orderly method.

B. Fiber optic patch panels shall be OFS Technologies "LGX," Corning Cable Systems "WCH Series," or equal.

2.4 WALL MOUNTED INSTRUMENT SUBPANELS

A. Instrument subpanels shall be constructed from 1/8 inch thick carbon steel and shall be reinforced and braced to form a rigid assembly. Panels designed for wall mounting shall have 1 inch turned back edges and a minimum 2 inch air space between the panel and the wall surface. All components on wall-mounted panels shall be mounted so as to be easily removable without requiring rear access to the subpanel.

2.5 PANEL MOUNTED INSTRUMENTS AND APPURTENANCES

A. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

1. Programming Device.

a. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2. Configuration Software/Serial Interface.

a. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a laptop computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 11 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device need not be furnished.

3. Panel Mounted Devices.

a. Alarm Horns.
1) Horns shall be high-decibel, panel-mount, vibrating type designed for heavy-duty use. Horn volume shall be field-adjustable from 78 to 103 dB at 10 feet. Horns shall operate at 120 volts ac. Horns shall be weatherproof NEMA Type 4X. Horns shall be panel front mounted and shall be supplied with gasket. Horns shall be Edwards Signals “870P Series.”

b. Digital Panel Indicators.
1) Digital indicators shall be designed for semi-flush mounting in a panel. The indicator shall be a 3 1/2 digit LED or LCD type display, with digits at least 0.5 inch high. The indicator shall be easily read at a distance of 10 feet in varying control room lighting environments. Operating temperature range shall be 32°F to 140°F. Accuracy shall be ±0.1 percent. The indicator shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The indicator shall have a selectable decimal point and shall provide over-range indication. Digital indicators shall be manufactured by Schneider Electric/Eurotherm/Action Instruments, Omega

Engineering, Inc./Newport Electronics, Precision Digital Corporation, or Red Lion Controls.

c. Switches, Lights, and Push Buttons.
   1) Selector Switches.
      a) Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T/H series”.
   2) Indicating Lights.
      a) Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Eaton/Cutler Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T/H series”.
   3) Push Buttons.
      a) Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T/H series”.

4. Panel Interior Mounted Appurtenances.

   a. Backup Power.
      1) Power supply to the panels shall be from electrical sources shown on the Drawings, which may be backed by redundant utility feeds, engine generators, or externally mounted uninterruptible power supplies (UPSs) specified in other sections.
      2) Where indicated in the attached equipment schedules, on the Drawings or in the referring equipment specifications, free-standing vertical panels and wall cabinets shall each be provided with an interior-mounted UPS to provide backup power to critical loads upon loss of power supply to the panel. UPS-backed power shall be provided to the programmable logic controller CPU, instrument loops, I/O modules (operating and wetting voltages), all network communications devices, and any other load essential to preventing loss of control system function. Backup power for panel interior lights, heaters, and convenience receptacles is not required. UPSs for free-standing vertical panels and wall cabinets shall meet the requirements specified below.
      3) Where required within the respective enclosure specification or shown on the Drawings, Freestanding EIA 19-Inch Rack Enclosures shall be furnished with an interior, rack-mounted UPS. UPSs for rack-type enclosures shall meet the requirements specified below.
      4) UPS for Free-Standing Vertical Panels and Wall Cabinets.

a) Each UPS shall accept incoming 120 volts ac, 60Hz, single-phase utility power, apply surge protection, and supply power to the connected loads. The UPS shall be a double-conversion ("on-line") type to provide a breakless transfer to backup power. In the event of incoming power failure, the UPS shall provide 120 volts ac, 60 Hz, single-phase power to its connected loads by inverting power stored within integral storage batteries. The UPS shall be contained inside the enclosure and supported by a dedicated shelf attached to the backplane or sidewall. The shelf shall be between 12 and 18 inches from the bottom of the enclosure and shall not be directly above any electronic or electromechanical devices.

b) The UPS shall have at least two integral NEMA 5-15R receptacles for connection of battery-backed loads. Upon restoration of incoming power, the UPS shall recharge the batteries and return its connected loads to the incoming power source. The factory-installed line cord and plug shall not be altered. The UPS output shall be connected by plug and line cord to terminal blocks as necessary to distribute power to loads not having a power cord and plug; all other loads shall be connected directly to the UPS's integral receptacles or to permanently installed receptacles fed from the UPS output.

c) The UPS shall maintain a temperature-compensated, float charge voltage on the batteries when utility power is available. Overcurrent protection when utility power is available shall be from an internal circuit breaker or other overload limiting internal device to the UPS. The UPS shall be intrinsically current-limiting when the unit is on battery.

d) The UPS shall meet the following requirements.

Capacity, minimum	1000 VA / 700 watts
Filtering and surge Protection (on utility power)	Meets IEEE/ANSI C62.41 Category B (IEEE 587)
Voltage, output (on battery)	120 volts ±3 percent
Voltage, output (on-line)	Nominal ±3 percent
Frequency and waveform, output (on battery)	60 ± 0.3 Hz, true sine-wave
Efficiency, minimum (on-line)	90 percent
Operating environment	0 to 40ºC; 0 to 95 percent relative humidity, non-condensing

Backup time, minimum at half of rated load	10 minutes
Recharge time, maximum to 90 percent of full charge	12 hours

e) The UPS shall have spare capacity of at least 30 percent based on actual connected loads. The System Supplier shall advise the Engineer if the UPS capacity needs to be higher than specified above to meet this requirement.

f) The UPS shall have a visual status indicator for low (or faulty) battery and incoming ac power failure. The UPS shall emit an audible signal or provide a signal output to communicate when the UPS is operating on battery power. A relay shall be installed within the panel and its coil connected across the UPS input power as a means of providing a contact for remote indication of a power failure condition.

g) The UPS shall be furnished with an Ethernet network card with RJ-45 connector for communicating status and alarm conditions to the Instrumentation and Control System HMI. Communication shall be via 10/100-BaseT Ethernet and shall use HTTP, SMTP, SNMP, Modbus TCP, or other protocol as necessary to transfer the information into the HMI database for display and alarming. Special software or drivers necessary to complete the communications link shall be furnished with the UPS systems. One copy of any special software or drivers necessary to allow monitoring over the network shall be provided for all UPSs furnished under this section.

h) Batteries shall be sealed maintenance-free, gelled electrolyte lead-acid, or valve-regulated, maintenance-free, lead-acid. Flooded-electrolyte type batteries will not be acceptable.

i) The UPS shall be APC “Smart-UPS On-Line”, Vertiv/Liebert “GXT45”, Toshiba “T1000 Series”, Phoenix Contact “QUINT4-UPS” series, or equal.

b. Power Supplies.

1) Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or shortcircuit protected. Output voltage regulation shall be by the instrumentation equipment supplied. Multiloop or multisystem power supplies will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. Multiloop power supply connections shall be individually fused so a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and shall be located for easy access. Multiloop supply systems shall

be oversized for an additional 10 percent future load. Failure of a multiloop supply shall be indicated on the respective instrument panel or enclosure.

2) Power supplies shall be Allen Bradley, Phoenix Contact, PULS, or equal.

3) Filter control systems may be designed so one power supply feeds all instrument loops common to one individual filter.

c. Relays.

1) Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition. Relays shall be IDEC "Series RR"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series 219, 246".

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Installation requirements are specified in the Instrumentation and Control System section. In addition, equipment furnished under this section shall conform to the following manufacturing stipulations.

1. Piping

a. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.

2. Wiring

a. All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

3. More Than One Panel

a. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic Drawings.

3.2 PANEL MOUNTED INSTRUMENT FIELD SERVICES.

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

Equipment Schedule 40 67 11-S01

FREESTANDING VERTICAL PANELS

1.000	**General**					
1.010	Specification Section 40 67 11					
2.000	**Freestanding Vertical Panels**					
2.010	Tag Number/Panel ID	Typical PLC Control Panel LCP-4000				
2.020	NEMA Enclosure Rating					
	12	X				
	4					
	4X					
2.030	Materials of construction					
	Carbon steel	X				
	316 Stainless steel					
	Fiberglass polyester					
2.040	Environmental provisions					
	Sunshade and drip shield					
	Cooling fan	X				
	Air conditioner					
2.050	Door Arrangements					
	Hinged rear doors					
	Hinged front door with instruments	X				
	Hinged front door without instruments					
	Fixed front					
	Recessed base					
2.060	Dimensions (max. H x W x D)	72”x60”x24”				
2.070	Panel interior-mounted UPS	X				
2.080	Conduit entrance					
	Bottom open					
	Removable top plates					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	None					

Equipment Schedule 40 67 11-S02

WALL-MOUNTED CABINETS

1.000	**General**					
1.010	Specification Section 40 67 11					
2.000	**Wall Mounted Cabinets**					
2.010	Tag Number/Panel ID	NOCL-LCP-4100	NHS-LCP-4200			
2.020	NEMA Enclosure Rating					
	12					
	3R					
	4					
	4X	X	X			
2.030	Materials of construction					
	Carbon steel					
	316 Stainless steel	X	X			
	Fiberglass polyester					
2.040	Environmental provisions					
	Sun shade					
	Cooling fan					
	Air conditioner					
2.050	Dimensions (max. H x W x D)	36”x24”x8”	36”x24”x8”			
2 060	Panel interior-mounted UPS					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	**None**					

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SECTION 40 68 83 - SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides functional descriptions of the PLC and computer software requirements for the Instrumentation and Control System as indicated on the Drawings. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

B. Control System

1. The Instrumentation and Control System section shall apply to all systems described in this section.

1.2 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The descriptions are applicable to the software specified in the Programmable Logic Controller section.

PART 3 - EXECUTION

3.1 PLC PROGRAMMING FUNCTIONAL REQUIREMENTS

A. The following paragraphs describe general configuration tasks that are required for the system PLC(s). These tasks shall be programmed in any applicable PLC. Each PLC may have multiple instances of each of these tasks, or may have no instances of some or all of these tasks. The input/output lists (located in these documents as specified in the Instrumentation and Control System section) and detailed equipment control descriptions (included herein) shall be referenced to determine the requirements for each PLC.

B. The following paragraphs cover functional requirements of the software, which are generic and may or may not be related to any specific control loop.

C. Available Process Values

1. All PLC-generated process alarm, equipment status, and process variable values shall be available at any operator workstation.

D. Flow Values

1. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the HMI computers and in the PLC processor will be identical.

E. System Failure

1. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.

F. HMI Computers

1. The HMI computers shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of the any HMI computer will not disrupt plant control.

G. Rack/Module Configuration

1. The rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.

H. PLC Database Definition

1. The PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.

I. Analog Scaling

1. Each analog input and output will be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

J. Equipment Runtimes

1. For each equipment item whose "run" status is monitored by a PLC, an internal equipment runtime shall be accumulated by the respective PLC. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution. The

timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running. The timer value shall increment an hour counter that maintains an integer value representing the equipment run time in hours. The counter value shall be available for display on the HMI computer. A manual reset of the runtime value shall be available at the HMI computers for personnel at the supervisor level and above.

K. Change-of-State Alarms

1. While equipment is controllable from the PLC ("in remote"), discrete output commands shall be compared to their respective process feedback status signal (where available) to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 300 second time delay), an alarm message shall be displayed on the HMI computer and the condition shall be logged as an alarm, requiring operator acknowledgment. The alarm shall remain energized until the proper discrete condition is sensed or until the operator resets the alarm through the HMI computer.

L. Equipment Availability

1. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).

M. Maintained/Momentary Outputs

1. The need for maintained or momentary control outputs shall be determined from the input/output listing and the electrical schematics. In general, equipment with only one control output indicated in the I/O list shall be programmed for a maintained control output. Equipment with two (or more) control outputs shall be programmed for momentary outputs. Provisions shall be made, in either case, to remove the active state (start, open, forward, initiate, etc.) control output when an equipment failure is sensed or when the equipment transitions from available to unavailable (local switch change).

N. Equipment Mode Changes

1. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.

O. Manual/Auto Bumpless Transfer

1. Unless otherwise indicated in the equipment control descriptions, equipment changes from automatic to manual control shall be bumpless. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.

3.2 HMI FUNCTIONAL REQUIREMENTS

A. The following paragraphs describe general configuration tasks that are required for the HMI and related software.

B. Database

1. The system database, including field I/O and internal points shall be established according to the database point naming conventions approved by Owner. Database generation for field I/O shall include all required coordination with PLC level addresses. If no Owner database point naming conventions are available, the database names shall utilize an ISA or ISA-like tag name.

2. In the default scheme, the format of the tag name is XXX-YYY-ZA.

   a. XXX is the ISA function designation.
   b. YYY-ZA is the unique loop designation defined by the P&IDs.

3. Where possible YYY-ZA will correspond to the loop numbers on the P&IDs. Otherwise, a unique number shall be assigned. Z is a number (1, 2, 3) to designate similar loops associated with trains of equipment. A is a letter (A, B, C) to designate identical functions within the same loop. For instance, if there are two ferric sulfate metering pumps and the loop number chosen is 222, the remote status input for pump number one might be HS-222-1 and the remote status input for pump number two might be HS-222-2. If there is more than one switch input for either pump the tag name would be HS-222-1A and the second switch would be HS-222-1B.

4. Function designations currently defined are listed below:

   a. AI's (Analog Inputs)
      1) AI – Analytical Input
      2) EI – Voltage Input
      3) EII – VAR Input
      4) FI – Flow Input
      5) II – Current Input
      6) JI – Power Input
      7) LI – Level Input
      8) PDI – Differential Pressure Input (Headloss)
      9) PI – Pressure Input
      10) SI – Speed or Rate Input
      11) TI – Temperature Input
      12) WI – Weight Input
      13) ZI – Position Input

   b. AO's
      1) AC – Residual Proportioning Control
      2) FC – Flow Proportioning Control
      3) SC – Speed or Rate Control
      4) ZC – Position Control

c. DI's
   1) AAH – Analytic Alarm High
   2) AAL – Analytic Alarm Low
   3) FAH – Flow Alarm High
   4) FAL – Flow Alarm Low
   5) JA – Electrical Alarm
   6) LAH – Level Alarm High
   7) LAHH – Level Alarm High-High
   8) LAL – Level Alarm Low
   9) LALL – Level Alarm Low-Low
   10) PDAH – Pressure Differential Alarm High
   11) PA – Pressure Alarm Hi/Lo or Unspecified
   12) PAL – Pressure Alarm Low
   13) PALL – Pressure Alarm Low-Low
   14) UA – Common Alarm
   15) WAL – Weight Alarm Low
   16) YA – General Alarm Event
   17) YI – Event Indication
   18) YIR – Running Indication
   19) ZIC – Position Indication Closed
   20) ZIO – Position Indication Open

d. DO's
   1) LC – PLC Generated LWCO Output
   2) XC – General Control Output
   3) YC – Equipment Start/Stop Command
   4) ZCC – Equipment Close Command
   5) ZCO – Equipment Open Command

5. Initially, the facility database shall be configured so all database points are defined as belonging to a specific area (as allowed by the graphical interface software). The areas designated for the facility shall be coordinated with Owner. If Owner has no existing standards for area designations, all points can be placed in appropriate areas selected by System Supplier.

C. Trend Displays

1. Trend displays shall be developed to present real-time and historical process data in an X-Y graph format. Real-time trends shall utilize current process values to generate temporary graphs that do not retain data values. Historical trends shall utilize historically collected data and shall access the data files directly for use in the trend display. Historical trends shall allow paging forward and back to the limits of the collected data. The trending package shall be configured to automatically retrieve historical data from the proper data file to accommodate the paging functions. Content of the trends will be determined after meeting with Owner. 8 real-time trend displays and 8 historical trend displays shall be provided.

D. Alarms

1. Complete system alarming shall be configured. This shall include configuration of graphical alarm displays, and configuration of audible alarms through the HMI speakers. All process or system alarms shall appear on an alarm summary screen and the alarm banner of each process graphic. Alarms and events shall be color coded on the alarm summary screen, with initial colors based on Owner conventions or the default colors associated with the graphics package. The colors may be adjusted after meeting with Owner. Alarm prioritizing and area assignments (if any) shall be coordinated with Owner at the first configuration meeting.

2. For LOW or LOW-LOW analog or discrete alarms which do not apply if associated equipment is not operating, provisions shall be made to prevent/Lock generation of the alarm unless the associated equipment is operating. This shall include alarms such as low amperage alarms for pumps that are not running. This may also include low flows or pressures when associated pumps are not operating (this will only apply if periodic operation of the equipment is considered normal).

3. All alarms/events shall be time stamped when displayed or printed. Unacknowledged alarms shall not automatically clear from the alarm summary if they return to normal before being acknowledged.

E. Reporting

1. System reporting shall be accomplished using the standard operator interface software-reporting package. All necessary report development, including macro development in spreadsheets, shall be supplied to access real-time and historical data for reporting. 2 historical, monthly facility reports shall be provided.

F. Historical Data Collection

1. System data shall be collected for historical archiving and for use in trending and reporting functions. Requirements for data collection shall be as needed to support the trends and reports developed.

G. Manual Entry of Data

1. The human machine interface (HMI) computers shall allow manual entry of laboratory data and other variables, which shall then be available for display and use in reports. Operator entered commands from any of the HMI computers shall be logged at all HMI computers.

3.3 EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW

A. The following paragraphs explain the general format and control modes that are used in the detailed equipment descriptions. These paragraphs apply to the attached, project specific, equipment control descriptions included herein.

B. General

1. Appended to this section are the equipment control programming requirements, with requirements for both PLC programming and the minimum operator interface functions. The HMI requirements represent the anticipated display generation requirements and shall be adjusted if the PLC programming warrants adjustment.

C. Control Modes

1. There are two general control modes available for the process equipment: 1) remote manual, and 2) remote auto. Remote manual control provides a means for operators to adjust equipment status or setpoint, through the HMI, using manually initiated commands. Remote automatic control provides a means for automatically changing equipment status or setpoint based on measured process parameters, calculated values, or operator setpoints. Some equipment may have more than one remote auto mode.

2. Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are hardwired and require no programming effort.

3.4 DETAILED EQUIPMENT CONTROL DESCRIPTIONS.

A. The following paragraphs describe specific function requirements for various software control blocks in the control system. These descriptions are intended to provide an overview of the operational concept for the facilities, rather than describing in detail every operating feature or interlock.

B. Lagoon Aerators

1. Associated Equipment

a. Existing Floating Brush Aerators (AFS-XXXX, AFS-XXXX)
b. Influent Pond Floating Brush Aerators LAG-AFS-2001, LAG-AFS-2002 (Future), LAG-AFS-2003 (Future), LAG-AFS-2004, LAG-AFS-2005, LAG-AFS-2006,
c. Polishing Pond Floating brush Aerators LAG-AFS-2011, LAG-AFS-2012.
d. LAG-MCC-WWTP

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-20-601

4. Local Manual Mode

a. Local Manual mode shall be provided at the MCC. The aerators shall run continuously when started at the MCC.

5. Local Auto Mode

    a. None.

6. Remote Manual Mode

    a. None.

7. Remote Auto Mode

    a. None.

8. Alarms

    a. None.

9. Status Indications

    a. Brush Aerator Running

10. Power Failure

    a. N/A

11. HMI Requirements

    a. All Floating Brush Aerators shall be depicted on the Lagoon HMI screen. The aerators symbols shall provide indication of running status.

12. Calculations

    a. None.

C. Widow's Creek Pump Station

1. Associated Equipment

    a. Cooling Water Pump No. 1 COLW-PVT-1510
    b. Cooling Water Pump No. 2 COLW-PVT-1520
    c. Cooling Water Pump No. 1 High Pressure Switch COLW-PSH-1511
    d. Cooling Water Pump No. 2 High Pressure Switch COLW-PSH-1521
    e. Wetwell No.1 Level transmitter COLW-LE/LIT-1511
    f. Wetwell No.1 Level switches COLW-LSH-1511, LSL-1511
    g. Wetwell No.2 Level transmitter COLW-LE/LIT-1521
    h. Wetwell No.2 Level switches COLW-LSH-1521, LSL-1521
    i. Widows Creek pumpstation Effluent Flowmeter COLW-FE/FIT-1500

2. Associated PLC

a. Existing PLC

3. Associated P&ID(s)

a. I-15-601

4. Local Manual Mode

a. When the Local-Off-Remote (LOR) selector switch at the AFD is in the “Local” position, the pump shall operate in Local Manual mode. In Local Manual mode, the pump shall be controlled at the AFD.
b. In Local Manual mode, the pump shall operate through the Start-Stop (SS) selector switch at the AFD, and speed shall be controlled through the speed selector.
c. In all control modes, the pump shall have a hardwired interlock stop the pump if the following conditions are detected:
    1) High Motor winding Temperature
    2) Low-Low Level in Wetwell one or two
    3) Estop is pressed.
    4) High Discharge Pressure.

d. If High level switch in any of the wetwell is triggered then an alarm shall be generated.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. When the LOR selector switch at the AFD is in the “Remote” position, and “Manual” is selected at the SCADA HMI, the pump shall operate in Remote Manual. In Remote Manual mode, the pump shall be controlled by the PLC through the HMI using the “Run Command” and speed shall be controlled using the data entry field.

7. Remote Auto Mode

a. When the LOR selector switch at the AFD is in the “Remote” position, and “Automatic” is selected at the SCADA HMI, the pump shall operate in Remote Auto mode. In Remote Auto mode, the pump operation and speed shall be controlled by the PLC.
b. A selector shall be provided at the HMI for each pump to allow the operator to assign duty and standby designation.
c. The speed of the duty pump shall be bound by Minimum and Maximum speed setpoints. The Minimum and Maximum speed setpoints shall be operator-adjustable at the SCADA HMI.
d. The duty pump shall start at minimum speed when the level in the wet well rises to the operator-adjustable Setpoint EL (initially set at 653.00).
e. If the duty pump fails to start within a configurable time delay, the standby pump shall be automatically commanded to start.

f. The PLC shall adjust the speed of the duty pump via a PID control loop to maintain the operator-adjustable Setpoint EL.
g. If High Level Switch is triggered (LHS-1511 or LSH-1521), the duty pump shall default to maximum speed.
h. Duty pump shall turn off at Low Level EL.
i. During continuous operation, duty/standby designation shall alternate at an operator-adjustable interval.

8. Alarms

a. High Pump Discharge Pressure
b. Pump Common Fail
c. Wetwell Low-Low Level (Typical for both wetwells)
d. Wetwell High Level (Typical for both wetwells)

9. Status Indications

a. Pump In Remote
b. Pump Running
c. Pump Speed
d. Pump Runtime
e. Wetwell Level (Typical for both wetwells)
f. Widow's Creek Pumpstation Flow.

10. Power Failure

a. Upon restoration of power, the pump shall return to the control mode previously established before power failure.

11. HMI Requirements

a. The Cooling water Pumps shall be depicted on the Cooling water Pump HMI screen. The display layout shall be similar to the P&ID. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of control mode (manual/auto), and pump control run command, and shall duplicate status indication as shown on the main display.

12. Calculations

a. None.

D. Sulfuric Acid Metering Pumps

1. Associated Equipment

a. Sulfuric Acid Tote Scales HSO4-WE/WIT-4001, HSO4-WE/WIT-4002
b. Sulfuric Acid Metering Pumps HSO4-PDM-4010, HSO4-PDM-4020

c. Metering Pump High Discharge Pressure Switches HSO4-PSH-4011, HSO4-PSH-4021

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-40-601

4. Local Manual Mode

a. Local Manual control of the metering pump shall be provided through an On-Off-Remote (OOR) switch on the metering pump control panel. When the OOR switch is in the "On" position the pump shall run continuously and the speed and stroke length shall be controlled using the local adjustment device on the panel.
b. In all control modes, the pump shall have hardwired interlocks to stop the pump when the high discharge pressure switch trips.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. When the OOR selector switch at the control panel is in the "Remote" position, and "Manual" is selected at the HMI, the pump shall operate in Remote Manual mode. In Remote Manual mode, the pump shall be controlled by the PLC through the HMI.
b. The pump shall operate using the Run Commands at the HMI. The operator shall control speed and stroke length manually using data entry fields at the HMI.

7. Remote Auto Mode

a. When the OOR selector at the control panel is in the "Remote" position, and "Automatic" is selected at the HMI, the pump shall operate in Remote Auto mode. In Remote Auto mode, the pump shall be controlled by the PLC.
b. In Remote Auto mode, the pump shall run and pump speed and stroke length shall be controlled by the flow pacing signal and the dosage (adjustable at the HMI from 0-X ppm) entered by the operator.
c. Stroke length control shall be preferential to speed control. The pump shall operate at an adjustable target speed (selectable at the HMI over the range of minimum to maximum speed, initially set at 50% of the operating speed range). Stroke length shall be controlled over the operating stroke length range to provide the pump output determined by the flow pacing signal and the dosage setpoint. If the stroke length reaches the upper or lower limit, the stroke length shall be held constant and the speed of the pump shall be increased or decreased to provide the required output. As demand varies and speed returns to the target speed, stroke length control shall resume with speed held constant. The pump output in

gallons per hour (feed rate) and the speed and stroke length setpoints shall be calculated as indicated below.

8. Alarms

   a. Pump High Discharge Pressure (typical for both pumps)
   b. Pump Common Fail (typical for both pumps)

9. Status Indications

   a. Storage Tote Weight (typical for both tote bases)
   b. Pump In Remote (Typical for both pumps)
   c. Pump Running (Typical for both pumps)
   d. Pump Stroke Length Feedback (Typical for both pumps)
   e. Pump Speed Feedback (Typical for both pumps)

10. Power Failure

   a. Upon restoration of power, pumps will return to the control mode previously established before power failure.

11. HMI Requirements

   a. The metering pump shall be depicted on the Sulfuric Acid feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (auto/man), manual control (ON/OFF and speed and stroke length adjustment), target speed setpoint, pump capacity [FR(MAX)], pump minimum feed rate [FR(MIN)], and shall duplicate status indication as shown on the main display.
   b. A separate control overlay display shall be provided for operator entry of chemical concentration and density. The control overlay display shall also provide for dosage or process value setpoint adjustment and PID tuning parameter adjustment, where applicable, for each feed point.
   c. Access to target speed, pump capacity, and pump minimum feedrate adjustment, PID tuning parameters, and chemical concentration and density setpoints shall be at the engineer's security level.

12. Calculations

   a. Feed Rate Calculation
   Dosage - Chemical dosage (ppm, adjustable at the HMI)
   Flowrate - Process flow at feed point (MGD)
   Conc - Chemical concentration expressed as a decimal (adjustable at the HMI)
   Density - Chemical density (lbs/gal, adjustable at the HMI)
   FR - Feed rate (gallons/hour)

   FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

b. Speed and Stroke Length Calculations

FR(Min) - Minimum feedrate (GPH, adjustable at the HMI)
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
FR(TgMin) - Feed rate at target speed and minimum stroke length (GPH)
FR(TgMax) - Feed rate at target speed and maximum stroke length (GPH)
SP - Stroke speed (strokes/min)
SP(Tg) - Target stroke speed (strokes/min, adjustable at the HMI)
SP(Min) - Minimum stroke speed (strokes/min)
SP(Max) - Maximum stroke speed (strokes/min)
ST - Stroke length (percent of maximum stroke length)
ST(Min) - Minimum stroke length (percent of maximum stroke length)

Between FR(Min) and FR(TgMin), stroke length shall be constant at ST(Min) and pump speed shall be calculated as follows:

SP = [FR x SP(Max) x 100%] / [ST(Min) x FR(Max)]

Between FR(TgMin) and FR(TgMax), speed shall be constant at the target speed and stroke length shall be calculated as follows:

ST = [FR x SP(Max) x 100%] / [FR(Max) x SP(Tg)]

Between FR(TgMax) and FR(Max), stroke length shall be held constant at ST(Max) and stroke speed shall be calculated as follows:

SP = [FR x SP(Max)] / FR(Max)

E. Sodium Hypochlorite Chemical Truck Unloading Panel

1. Associated Equipment

a. Chemical Truck Unloading Panel NOCL-LCP-4100
b. Sodium Hypochlorite Storage Tank NOCL-TNK-4101
c. Storage Tank Level Transmitter NOCL-LE/LIT-4101
d. Storage Containment Area Leak Detection NOCL-LSH-4100
e. Sodium Hypochlorite Metering Pumps NOCL-PDM-4110, NOCL-PDM-4120
f. Metering Pump High Discharge Pressure Switches NOCL-PSH-4111, NOCL-PSH-4121

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-40-603

4. Local Manual Mode

a. Local Manual control of the chemical storage tank filling operation shall be provided through the chemical truck unloading panel.
b. Prior to unloading, the operator shall connect the delivery hose from the chemical delivery truck to the tank fill connection and place the unloading system in service using the controls provided at the chemical truck unloading panel.
c. The chemical truck unloading panel shall provide indication of storage tank level and shall monitor associated tank level switches and leak detection devices.
d. Upon detection of High storage tank level alarm or containment leak alarm, the unloading operation shall be stopped, and the valves shall be closed manually.
e. Audible and visual alarms shall be provided locally at the chemical truck unloading panel for High Storage tank level and leak detection conditions. The operator shall stop the unloading operation locally upon completion of chemical transfer.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. None.

7. Remote Auto Mode

a. None.

8. Alarms

a. Leak detection
b. High Storage tank level.

9. Status Indications

a. Storage tank level

10. Power Failure

a. Upon restoration of power, the Chemical Truck Unloading Panel shall return to its previous operating state. Any active unloading operation shall require operator verification and manual restart at the local panel..

11. HMI Requirements

a. The chemical storage tanks and associated truck unloading panel shall be depicted on the PLC-4000 HMI. The display shall provide storage tank level indication, unloading status, alarm status and leak detection status.
b. The HMI shall provide alarm indication for high storage tank level and leak detection conditions and shall allow operators to acknowledge alarms.
c. Historical and real-time storage tank level trends shall be available through HMI.

12. Calculations: None

F. Sodium Hypochlorite Metering Pumps

1. Associated Equipment

a. Chemical Truck Unloading Panel NOCL-LCP-4100
b. Sodium Hypochlorite Storage Tank NOCL-TNK-4101
c. Storage Tank Level Transmitter NOCL-LE/LIT-4101
d. Storage Containment Area Leak Detection NOCL-LSH-4100
e. Sodium Hypochlorite Metering Pumps NOCL-PDM-4110, NOCL-PDM-4120
f. Metering Pump High Discharge Pressure Switches NOCL-PSH-4111, NOCL-PSH-4121

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-40-603
b. I-40-604

4. Local Manual Mode

a. Local Manual control of the metering pump shall be provided through an On-Off-Remote (OOR) switch on the metering pump control panel. When the OOR switch is in the "On" position the pump shall run continuously and the speed and stroke length shall be controlled using the local adjustment device on the panel.
b. In all control modes, the pump shall have hardwired interlocks to stop the pump when the high discharge pressure switch trips.
c. In all control modes, the pumps shall be called to stop running if the following conditions are detected:
    1) Low level in storage tank (Programmed in the PLC)
    2) Leak detected in containment area.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. When the OOR selector switch at the control panel is in the "Remote" position, and "Manual" is selected at the HMI, the pump shall operate in Remote Manual mode. In Remote Manual mode, the pump shall be controlled by the PLC through the HMI.
b. The pump shall operate using the Run Commands at the HMI. The operator shall control speed and stroke length manually using data entry fields at the HMI.

7. Remote Auto Mode

a. When the OOR selector at the control panel is in the "Remote" position, and "Automatic" is selected at the HMI, the pump shall operate in Remote Auto mode. In Remote Auto mode, the pump shall be controlled by the PLC.
b. In Remote Auto mode, the pump shall run and pump speed and stroke length shall be controlled by the flow pacing signal and the dosage (adjustable at the HMI from 0-X ppm) entered by the operator.
c. Stroke length control shall be preferential to speed control. The pump shall operate at an adjustable target speed (selectable at the HMI over the range of minimum to maximum speed, initially set at 50% of the operating speed range). Stroke length shall be controlled over the operating stroke length range to provide the pump output determined by the flow pacing signal and the dosage setpoint. If the stroke length reaches the upper or lower limit, the stroke length shall be held constant and the speed of the pump shall be increased or decreased to provide the required output. As demand varies and speed returns to the target speed, stroke length control shall resume with speed held constant. The pump output in gallons per hour (feed rate) and the speed and stroke length setpoints shall be calculated as indicated below.

8. Alarms

a. Pump High Discharge Pressure (typical for both pumps)
b. Pump Common Fail (typical for both pumps)

9. Status Indications

a. Pump In Remote (typical for both pumps)
b. Pump Running (typical for both pumps)
c. Pump Stroke Length Feedback (typical for both pumps)
d. Pump Speed Feedback (typical for both pumps)

10. Power Failure

a. Upon restoration of power, pumps will return to the control mode previously established before power failure.

11. HMI Requirements

a. The metering pump shall be depicted on the Sodium Hypochlorite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (auto/man), manual control (ON/OFF and speed and stroke length adjustment), target speed setpoint, pump capacity [FR(MAX)], pump minimum feed rate [FR(MIN)], and shall duplicate status indication as shown on the main display.
b. A separate control overlay display shall be provided for operator entry of chemical concentration and density. The control overlay display shall also provide for dosage or process value setpoint adjustment and PID tuning parameter adjustment, where applicable, for each feed point.

c. Access to target speed, pump capacity, and pump minimum feed rate adjustment, PID tuning parameters, and chemical concentration and density setpoints shall be at the engineer's security level.

12. Calculations

a. Feed Rate Calculation
Dosage - Chlorine dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc - Chlorine concentration expressed as a decimal (adjustable at the HMI)
Density - Chemical density (lbs/gal, adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

b. Speed and Stroke Length Calculations
FR(Min) - Minimum feedrate (GPH, adjustable at the HMI)
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
FR(TgMin) - Feed rate at target speed and minimum stroke length (GPH)
FR(TgMax) - Feed rate at target speed and maximum stroke length (GPH)
SP - Stroke speed (strokes/min)
SP(Tg) - Target stroke speed (strokes/min, adjustable at the HMI)
SP(Min) - Minimum stroke speed (strokes/min)
SP(Max) - Maximum stroke speed (strokes/min)
ST - Stroke length (percent of maximum stroke length)
ST(Min) - Minimum stroke length (percent of maximum stroke length)

Between FR(Min) and FR(TgMin), stroke length shall be constant at ST(Min) and pump speed shall be calculated as follows:

SP = [FR x SP(Max) x 100%] / [ST(Min) x FR(Max)]

Between FR(TgMin) and FR(TgMax), speed shall be constant at the target speed and stroke length shall be calculated as follows:

ST = [FR x SP(Max) x 100%] / [FR(Max) x SP(Tg)]

Between FR(TgMax) and FR(Max), stroke length shall be held constant at ST(Max) and stroke speed shall be calculated as follows:

SP = [FR x SP(Max)] / FR(Max)

G. Sodium Bisulfite Chemical Truck Unloading Panel

1. Associated Equipment

a. Chemical Truck Unloading Panel NHS-LCP-4100
b. Sodium Hypochlorite Storage Tank NHS-TNK-4101

c. Storage Tank Level Transmitter NHS-LE/LIT-4101
d. Storage Containment Area Leak Detection NHS-LSH-4100
e. Sodium Hypochlorite Metering Pumps NHS-PDM-4110, NHS-PDM-4120
f. Metering Pump High Discharge Pressure Switches NHS-PSH-4111, NHS-PSH-4121

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-40-605

4. Local Manual Mode

a. Local Manual control of the sodium bisulfite chemical storage tank filling operation shall be provided through the chemical truck unloading panel.
b. Prior to unloading, the operator shall connect the delivery hose from the chemical delivery truck to the tank fill connection and place the unloading system in service using the controls provided at the chemical truck unloading panel.
c. The chemical truck unloading panel shall provide indication of storage tank level and shall monitor associated tank level switches and leak detection devices.
d. Upon detection of High storage tank level alarm or containment leak alarm, the unloading operation shall be stopped, and the valves shall be closed manually.
e. Audible and visual alarms shall be provided locally at the chemical truck unloading panel for High Storage tank level and leak detection conditions. The operator shall stop the unloading operation locally upon completion of chemical transfer.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. None.

7. Remote Auto Mode

a. None.

8. Alarms

a. Leak detection
b. High Storage tank level.

9. Status Indications

a. Storage tank level

10. Power Failure

    a. Upon restoration of power, the Chemical Truck Unloading Panel shall return to its previous operating state. Any active unloading operation shall require operator verification and manual restart at the local panel..

11. HMI Requirements

    a. The chemical storage tanks and associated truck unloading panel shall be depicted on the PLC-4000 HMI. The display shall provide storage tank level indication, unloading status, alarm status and leak detection status.
    b. The HMI shall provide alarm indication for high storage tank level and leak detection conditions and shall allow operators to acknowledge alarms.
    c. Historical and real-time storage tank level trends shall be available through HMI.

12. Calculations: None

H. Sodium Bisulfite Metering Pumps

1. Associated Equipment

    a. Chemical Truck Unloading Panel NHS-LCP-4200
    b. Sodium Bisulfite Storage Tank NHS-TNK-4201
    c. Storage Tank Level Transmitter NHS-LE/LIT-4201
    d. Storage Containment Area Leak Detection NHS-LSH-4200
    e. Sodium Bisulfite Metering Pumps NHS-PDM-4210, NHS-PDM-4220
    f. Metering Pump High Discharge Pressure Switches NHS-PSH-4211, NHS-PSH-4221

2. Associated PLC

    a. PLC-4000

3. Associated P&ID(s)

    a. I-40-605
    b. I-40-606

4. Local Manual Mode

    a. Local Manual control of the metering pump shall be provided through an On-Off-Remote (OOR) switch on the metering pump control panel. When the OOR switch is in the “On” position the pump shall run continuously and the speed and stroke length shall be controlled using the local adjustment device on the panel.
    b. In all control modes, the pump shall have hardwired interlocks to stop the pump when the high discharge pressure switch trips.
    c. In all control modes, the pumps shall be called to stop running if the following conditions are detected:
        1) Low level in storage tank (Programmed in the PLC)

2) Leak detected in containment area.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. When the OOR selector switch at the control panel is in the “Remote” position, and “Manual” is selected at the HMI, the pump shall operate in Remote Manual mode. In Remote Manual mode, the pump shall be controlled by the PLC through the HMI.
b. The pump shall operate using the Run Commands at the HMI. The operator shall control speed and stroke length manually using data entry fields at the HMI.

7. Remote Auto Mode

a. When the OOR selector at the control panel is in the “Remote” position, and “Automatic” is selected at the HMI, the pump shall operate in Remote Auto mode. In Remote Auto mode, the pump shall be controlled by the PLC.
b. In Remote Auto mode, the pump shall run and pump speed and stroke length shall be controlled by the flow pacing signal and the dosage (adjustable at the HMI from 0-X ppm) entered by the operator.
c. Stroke length control shall be preferential to speed control. The pump shall operate at an adjustable target speed (selectable at the HMI over the range of minimum to maximum speed, initially set at 50% of the operating speed range). Stroke length shall be controlled over the operating stroke length range to provide the pump output determined by the flow pacing signal and the dosage setpoint. If the stroke length reaches the upper or lower limit, the stroke length shall be held constant and the speed of the pump shall be increased or decreased to provide the required output. As demand varies and speed returns to the target speed, stroke length control shall resume with speed held constant. The pump output in gallons per hour (feed rate) and the speed and stroke length setpoints shall be calculated as indicated below.

8. Alarms

a. Pump High Discharge Pressure (typical for both pumps)
b. Pump Common Fail (typical for both pumps)

9. Status Indications

a. Pump In Remote (typical for both pumps)
b. Pump Running (typical for both pumps)
c. Pump Stroke Length Feedback (typical for both pumps)
d. Pump Speed Feedback (typical for both pumps)

10. Power Failure

a. Upon restoration of power, pumps will return to the control mode previously established before power failure.

11. HMI Requirements

a. The metering pump shall be depicted on the Sodium Bisulfite feed system display. The pump symbol shall be a selectable target which retrieves the respective control overlay display. The overlay display shall contain control targets which allow selection of pump control modes (auto/man), manual control (ON/OFF and speed and stroke length adjustment), target speed setpoint, pump capacity [FR(MAX)], pump minimum feed rate [FR(MIN)], and shall duplicate status indication as shown on the main display.
b. A separate control overlay display shall be provided for operator entry of chemical concentration and density. The control overlay display shall also provide for dosage or process value setpoint adjustment and PID tuning parameter adjustment, where applicable, for each feed point.
c. Access to target speed, pump capacity, and pump minimum feed rate adjustment, PID tuning parameters, and chemical concentration and density setpoints shall be at the engineer's security level.

12. Calculations

a. Feed Rate Calculation
Dosage - Chemical dosage (ppm, adjustable at the HMI)
Flowrate - Process flow at feed point (MGD)
Conc - Chemical concentration expressed as a decimal (adjustable at the HMI)
Density - Chemical density (lbs/gal, adjustable at the HMI)
FR - Feed rate (gallons/hour)

FR = [Dosage x 8.34 x Flowrate] / [Conc x Density x 24]

b. Speed and Stroke Length Calculations
FR(Min) - Minimum feedrate (GPH, adjustable at the HMI)
FR(Max) - Pump capacity (GPH, adjustable at the HMI)
FR(TgMin) - Feed rate at target speed and minimum stroke length (GPH)
FR(TgMax) - Feed rate at target speed and maximum stroke length (GPH)
SP - Stroke speed (strokes/min)
SP(Tg) - Target stroke speed (strokes/min, adjustable at the HMI)
SP(Min) - Minimum stroke speed (strokes/min)
SP(Max) - Maximum stroke speed (strokes/min)
ST - Stroke length (percent of maximum stroke length)
ST(Min) - Minimum stroke length (percent of maximum stroke length)

Between FR(Min) and FR(TgMin), stroke length shall be constant at ST(Min) and pump speed shall be calculated as follows:

SP = [FR x SP(Max) x 100%] / [ST(Min) x FR(Max)]

Between FR(TgMin) and FR(TgMax), speed shall be constant at the target speed and stroke length shall be calculated as follows:

ST = [FR x SP(Max) x 100%] / [FR(Max) x SP(Tg)]

Between FR(TgMax) and FR(Max), stroke length shall be held constant at ST(Max) and stroke speed shall be calculated as follows:

SP = [FR x SP(Max)] / FR(Max)

I. Engine-Generators

1. Final control narrative shall be supplied by the Engine-Generator System Supplier. For further requirements, refer to Engine-Generators specification 26 32 12 and Bypass-Isolation Automatic Transfer Switches specification 26 36 26.

2. Associated Equipment

   a. Engine-Generator Package FUE-GEN-5000
   b. Automatic Transfer Switch FUE-ATS-5000
   c. Engine generator package Instruments Audible Alarm FUE-AAX-5001, Engine Generator Sub base tank Level and temperature instruments FUE-LIT-5001, FUE-LSHH-5001, FUE-LSH-5001, FUE-TSH-5001, FUE-TSL-5001, FUE-LSL-5001, Primary fuel tank Leak detection FUE-LSH-5001.

3. Associated PLC

   a. PLC-5000

4. Associated P&ID(s)

   a. I-50-601

5. Local Manual Mode

   a. Local Manual control shall be provided at the Engine-Generator Local Control Panel. Control sequencing shall be provided by the Engine-Generator System Supplier.

6. Local Auto Mode

   a. Local Auto control shall be provided at the Automatic Transfer Switch. Control sequencing shall be provided by the Engine-Generator System Supplier.

7. Remote Manual Mode

   a. None.

8. Remote Auto Mode

a. None.

9. Alarms

a. In Emergency Connection
b. Engine-Generator Common Fail

10. Status Indications

a. In Normal Connection
b. Emergency Power Available
c. Normal Power Available
d. Engine-Generator Running

11. Power Failure

a. N/A

12. HMI Requirements

a. The Engine-Generator shall be displayed on the Engine-Generator HMI screen. Display shall include status and alarm indication for engine-generator and automatic transfer switches.

13. Calculations

a. None.

J. Chlorine Contact Basin and Modulating Weir:

1. Associated Equipment

a. Junction Structure Level TE-LE/LIT-3000,
b. Cooling water valve and instrument station instruments TE-PG-3001, TE-AE/AIT-3006, TE-AE/AIT-3007, TE-TE/TIT-3006, TE-FG-3001
c. Chlorine Contact basin instruments TE-AE/AIT-3001, TE-AE/AIT-3004, TE-LE/LIT-3001, TE-FE/FIT-3004, TE-AE/AIT-3002, TE-AE/AIT-3003, TE-AE/AIT-3005.

2. Associated PLC

a. PLC-4000

3. Associated P&ID(s)

a. I-30-601

4. Local Manual Mode

a. Local Manual control shall be provided at the Weir actuator. When operator selects 'Local' control mode using the 'Local-Off-Remote' selector switch, operator shall be able to Lower the Weir using the 'Close' control mode using the 'Open-Stop-Close' selector switch. Operator shall be able to Raise the weir by selecting Open control mode using the 'Open-Stop-Close' selector switch. When Operator select 'Off' control mode using the 'Local-Off-Remote' selector switch then Weir shall completely raise to it's maximum position to disconnect the chlorine contact basin.
b. In any control mode the Weir shall be fully lowered when Level in the junction structure reaches a Highest level as programmed using PLC and measured by LE/LIT-3000.

5. Local Auto Mode

a. None.

6. Remote Manual Mode

a. When operator selects 'Remote' control mode using the 'Local-Off-Remote' selector switch and 'Manual' control mode is selected at the PCS HMI, operator shall be able to control Raising/Lowering of the weir from the Plant PCS HMI.

7. Remote Auto Mode

a. When operator selects 'Remote' control mode using the 'Local-Off-Remote' selector switch and 'Automatic' control mode is selected at the PCS HMI, the PLC-4000 shall control the operation of the weir based upon the level in the Junction structure. The PLC-4000 shall also continuously monitor the basin level as measured using LE/LIT-3001 and adjust the weir to maintain the target operating level in the chlorine basin
b. Effluent flowrate, basin level, chlorine residual, pH, dissolved oxygen and alkalinity measurements shall be continuously monitored and made available to the PCS system.
c. Based upon the effluent flow rate and chlorine residual measurements, sodium bisulfate dosing shall be determined.

8. Alarms

a. Weir Fault
b. Chlorine basin high level
c. Junction structure high level

9. Status Indications

a. Chlorine contact basin level
b. Junction Structure Level
c. Chlorine residual (Typical for all chlorine analyzers)
d. Influent treated effluent Alkalinity
e. Influent treated effluent temperature
f. Discharge treated effluent pH

g. Discharge treated effluent dissolved oxygen

10. Power Failure

a. Upon restoration of power, PLC-4000 shall restore communication with all associated instrumentation and resume process monitoring. The gate actuator shall return to the control mode established prior to power failure.

11. HMI Requirements

a. The Chlorine contact basin shall be displayed on the PCS HMI screen.
b. The display shall include Basin level, junction structure level, gate position, chlorine residual, effluent flow rate, pH, dissolved oxygen, and alkalinity indication.
c. The operator shall be able to adjust the basin level control setpoint from the HMI at the appropriate level.
d. Historical and real-time trends shall be provided for all analyzers, Basin and junction structure levels and effluent flow rate.
e. The display shall provide alarm indications and alarm acknowledgements functions for all configured basin alarms.

12. Calculations

a. None.

End of Section

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SECTION 40 71 00 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of flow instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

D. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Where possible, each instrument shall be factory wet flow calibrated to the full scale flow range of the sensors or calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration and configuration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or Instrument Device Schedule.

F. Flow instruments that come in contact with potable water, water in the drinking water treatment process, or water treatment chemical systems shall conform to ANSI/NSF 61 or its equivalent for international projects as applicable and shall be in accordance with policies governing the safety of public drinking water as stipulated by local, state, and federal statutes.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device requirements. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated on the Drawings or in the Instrument Device Schedule. The interconnecting cable shall be provided in the length necessary for installation. Splices shall not be allowed in the installed cable.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 11 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 FLOW INSTRUMENTATION.

A. Magnetic Flow Meters, Signal Converters, and Accessories.

1. Magnetic Flow meter

a. The magnetic flow meter shall be a completely obstruction less, in-line flow meter with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings or grounding electrodes as required by the application. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5 for line sizes from 0.5 inches to 24 inches or AWWA C207 for line sizes larger than 24 inches . Flange class ratings and meter maximum pressure ratings shall be compatible with the adjoining piping. Flangeless wafer insert style meters may be used for pipe sizes up to 6 inches , where compatible with adjacent piping flanges. Self-cleaning electrodes shall be provided for all meters used for sludge metering. Electrode and liner materials shall be fully compatible with the process fluid as approved by the Engineer and shall comply with the requirements specified in the Instrument Device Schedules. Each meter shall be factory wet flow calibrated to the sensors full flow capacity, at a facility, which is traceable to NIST or other standard acceptable to Engineer, and a copy of the calibration, report shall be submitted as part of the operation and maintenance manual submittal.

b. The meter shall be capable of standing empty for extended periods of time without damage to any components.

c. The meter housing shall be of a splash-proof and drip-proof design, unless indicated on the Drawings or in the Instrument Device Schedule to be submersible. Where required to be submersible, the meter housing shall withstand submergence in 30 feet of water for 48 hours without damage.

d. Where indicated on the Drawings or in the Instrument Device Schedule, the meter shall be suitable for use in a Class I, Division 2, hazardous area.

e. Meters shall be manufactured by ABB, Endress+Hauser, Schneider Electric, Krohne, Rosemount, or Siemens.

2. Magnetic Flow Meter Signal Converters

a. Separately mounted, microprocessor-based signal converters shall be provided for the magnetic flow meters. The signal converters shall include output damping, self-testing, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flow meter transmitter and signal converter shall

be ±0.5 percent of actual flow rate for full-scale settings of 3 to 30 fps . The meter manufacturer shall furnish the signal cable between the converter and the magnetic flow meter. Signal cable shall be continuous and not spliced between the meter and the signal converter. The signal converter shall be housed in a corrosion-resistant, weatherproof NEMA Type 4X housing and shall be suitable for operation over an ambient temperature range of -30 to +140°F , and relative humidity of 10 to 100 percent. The converter shall have an analog output of 4-20 mA dc. Transmitters tagged on the Drawings or specified to be of the indicating type shall contain a local indicator with a minimum four digit LCD type display, scaled to read in engineering units of flow.

b. Magnetic flow meter systems shall provide zero flow stability by means of automatic zero adjustment of a DC excited metering circuit. Converters shall be capable of bi-directional flow measurement. Signal converters shall be of the same brand as the magnetic flow meters.

c. Where indicated on the Drawings or in the Instrument Device Schedule, the signal converter shall have a non-reset seven-digit totalizer on the face of the enclosure.

d. The signal converter shall be diagnosed and recalibrated with the use of a hand-held communicator/calibrator device. One device shall be furnished for all converters provided by a single manufacturer.

B. Open Channel Ultrasonic Flowmeters

1. Each ultrasonic flow meter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and an interconnecting cable. The sensor shall be encapsulated in a chemical- and corrosion-resistant material such as kynar or CPVC and shall be suitable for operation over a temperature range of -20 to +150°F , with a relative humidity of 10 to 100 percent. Sensors shall be compatible with the process media being measured. The sensor shall be mounted directly over the flume or weir channel and shall measure the fluid level by means of reflected high frequency sound waves. Sensors mounted in direct sunlight shall be provided with sunshades.

2. The supplier shall coordinate the sensor mounting requirements and shall furnish drawings, complete with dimensions and elevations, to ensure a proper and satisfactory installation. General installation requirements are indicated on the Drawings.

3. The ultrasonic flow meter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units of flow. Digit height shall be approximately 0.5 inch . The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA dc signal linearly proportional to flow. The signal converter shall use a microprocessor-based digital flow linearizer circuit that can be easily changed in the field. Calibration parameters shall be stored in nonvolatile EEPROM memory. Accuracy of the transmitted signal shall be ±1 percent of the flow range.

4. A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet from the signal converter.

5. When indoor installation is required, the signal converter electronics shall be housed in a NEMA Type 12 enclosure suitable for wall or pipestand mounting and for operating temperatures of +30 to +120°F

6. When outdoor installation is required, the signal converter electronics shall be housed in a weatherproof, corrosion-resistant NEMA Type 4 enclosure suitable for wall or pipestand mounting and for operating temperatures of -15 to +125°F , and a relative humidity of 10 to 100 percent.

7. The signal converter shall be of the ac-powered type.

8. Where indicated on the Drawings or in the Instrument Device Schedule, the signal converter shall contain an integral flow integrator that produces a scaled pulse contact type output suitable for operating a remote totalizer.

9. The ultrasonic flow transmitter shall be Ametek/Drexelbrook “USonic-R”, Siemens "LUT-400", Endress+Hauser “Prosonic”, Pulsar “Ultra 5”, or STI/Magnetrol "Echotel 355".

C. Rotameters (Liquid Service).

1. Rotameters shall be all metal variable area type utilizing an integral orifice plate and conical float. Float position shall be directly visible through a sealed glass or plexiglass viewing window. Flow scale shall be engraved on the viewing window. Flowmeter components shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, flowmeter wetted components shall be AISI Type 316 stainless steel. Float viewing window materials shall be compatible with the measured process, as indicated in the Instrument Device Schedule. Flowmeter connections shall be 150-lb ANSI flanges.

2. Where indicated in the Drawings or Instrument Device Schedule, flow meter float position shall be magnetically transmitted to an external indicating unit that linearizes and displays the flow in engineering units as indicated in the Instrument Device Schedule. All electronic components associated with this accessory shall be rated NEMA Type 4.

3. Where indicated in the Drawings or Instrument Device Schedule, flowmeters shall be provided with an adjustable, magnetic actuated switch. The switch shall actuate at the flow value listed in the Drawings or the Instrument Device Schedule. Switches shall be rated 5 amp [A] at 120 V ac.

4. Each rotameter shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.

5. Mounting and installation hardware shall be AISI Type 316L stainless steel. Liquid service rotameters shall be ABB or equal.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 40 72 00 - PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of pressure and level instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. No level or pressure instrumentation shall use mercury in switches or any other internal components.

D. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

E. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

F. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type.

Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

G. Pressure and level instruments that come in contact with potable water, water in the drinking water treatment process, or water treatment chemical systems shall conform to ANSI/NSF 61 or its equivalent for international projects as applicable and shall be in accordance with policies governing the safety of public drinking water as stipulated by local, state, and federal statutes.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.

C. Programming Device

1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 11 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PRESSURE AND LEVEL INSTRUMENTATION.

A. Adjustable Deadband Float Type Level Switches

1. Level switches shall consist of a non-mercury type switch element encapsulated in a nominal 5 inch diameter PVC float housing. The switch contact shall be single-pole, double-throw, rated 10 amp [A] at 120 V ac. The float shall be supported from a flexible three-conductor 18 AWG cable that also acts as the float hinge. The cable shall be suitable for fixed mount or weighted suspension type installation as indicated on the Drawings or in the Instrument Device Schedule. All necessary mounting hardware shall be provided. The hinge-cable length shall be field adjustable in a manner that allows the deadband to be adjusted between 9 inches and 3 feet . The float switch shall be Magnetrol "T10" or equal.

B. Flood Level Switches

1. The flood detecting level switches shall be float actuated and shall be suitable for wall bracket or sump mounting, as indicated on the Drawings or in the Instrument Device Schedule. The switch float mechanism shall actuate when the water level rises to 1 inch above the bottom of the housing. The switch contacts shall be hermetically sealed, rated for 0.1 amp [A] at 120 V ac, and shall be field changeable from normally open to normally closed. Flood switches shall be Contegra "Model FS 202".

C. Pressure Switches

1. Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual pressure. Switches shall have over-range protection to maximum process line pressure. Switches mounted inside panels shall have NEMA Type 1 housings. All other switches shall have weatherproof housings. Switches shall be differential type where indicated in the Instrument Device Schedule. Switch wetted parts shall be compatible with the process fluid. Where the process is not defined, all wetted parts shall be Teflon-coated or viton and the connection port shall be stainless steel. Pressure switches shall not use mercury switches.

2. Panel-mounted and surface-mounted switches shall be provided with 1/4 inch NPT connections. All stem-mounted switches shall be provided with 1/2 inch NPT connections.

3. All pressure switches shall be ranged in psi and all vacuum switches in inches of water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp [A] at 120 V ac.

4. Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be compatible with the process fluid. Where the process is not specified, valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port valves shall have all unused ports plugged. Shutoff valve construction shall be as detailed in the Miscellaneous Instruments section.

5. Where indicated on the Drawings or in the Instrument Device Schedule, the switch shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the switch served. Snubbers shall be Ashcroft "Pulsation Dampers", or approved equal.

6. Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the switch with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

7. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All switches, snubbers, and diaphragm seals shall be installed in the vertical, upright position. All wetted components of the pressure switch, snubber, shutoff valve, and/or diaphragm seal shall be constructed of the same material to prevent galvanic corrosion when in contact with an electrolytic process fluid. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation of the switch or diaphragm seal.

8. Switches shall be manufactured by Ashcroft, Barksdale, Dwyer/Mercoid, ITT/NeoDyn, or S.O.R.

D. Ultrasonic Level Transmitters

1. Each ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and an interconnecting cable. The sensor shall be encapsulated in a chemical and corrosion-resistant material such as kynar or CPVC, and shall be suitable for operation over a temperature range of -20° to +150°F and a relative humidity of 10 to 100 percent. The sensor shall be compatible with the process media being measured. Sensors mounted in areas subject to freezing shall be provided with special transducers or protected against icing by heaters. Sensors mounted in direct sunlight shall be provided with sunshades.

2. The supplier shall coordinate the sensor mounting requirements and furnish drawings complete with dimensions and elevations. General installation requirements are indicated on the Drawings.

3. The ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 1/2 inch. The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA dc signal linearly proportional to the measured level range, or where indicated on the Drawings or in the Instrument Device Schedule, shall be characterized to be proportional to the tank volume. Calibration parameters shall be entered through a keypad on the unit and shall be stored in nonvolatile EEPROM memory. Accuracy of the transmitted signal shall be ±0.5 percent of the level range.

4. Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall be a differential level-sensing unit that accepts inputs from two ultrasonic level sensors. The transmitter output shall be proportional to the difference in level. The differential value shall be displayed on the unit. An adjustable alarm contact, actuated by differential level, shall be provided.

5. Where indicated on the Drawings or in the Instrument Device Schedule, the transmitter shall contain three independently adjustable level alarm contact outputs. Contacts shall be single-pole, single-throw rated not less than 5 amperes at 120 V ac.

6. A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet from the signal converter.

7. For indoor installation, the signal converter electronics shall be housed in a NEMA Type 12 enclosure suitable for wall or pipestand mounting and for operating temperatures of +30° to +120°F.

8. For outdoor installation, the signal converter electronics shall be housed in a weatherproof, corrosion-resistant NEMA Type 4 enclosure suitable for wall or pipestand mounting and for operating temperatures of -5° to +122°F and a relative humidity of 10 to 100 percent. A thermostatically controlled strip heater shall be provided in the signal converter enclosure.

9. Signal converters shall be of the ac-powered type. The ultrasonic level transmitter shall be Siemens “HydroRanger 200HMI”, Pulsar “Ultra 4”, or Endress+Hauser “Prosonic”.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 40 73 12 - PRESSURE GAUGES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers analog dial-type gauges and accessories to be furnished and installed at the locations indicated on the Drawings.

B. Gauges to be furnished by an equipment supplier, either with an item of equipment or as a component of an equipment package, are covered in the applicable equipment section.

C. Gauge piping and fittings are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Governing Standard

1. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI/ASME B40.1.

C. Accuracy Grade

1. Unless otherwise specified, gauge accuracy shall be ANSI Grade 2A or better. Overall accuracy for diaphragm seal protected and liquid-filled gauges shall be ANSI Grade A or better.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

B. Drawings and Data.

1. Complete drawings or catalog cuts, together with detailed specifications and data covering materials used, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 GAUGE CONSTRUCTION

A. Unless otherwise specified, gauges shall be indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene solid front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

B. The dial shall be 4-1/2 inches in diameter, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees nor more than 270 degrees of arc.

C. Unless otherwise indicated, pressure gauges shall measure in psig and vacuum gauges shall measure in inches Hg vacuum. All gauges shall have a suitable range to give mid-scale readings under normal conditions

D. Flush-mounted and surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.

E. Gauges that come in contact with potable water, water in the drinking water treatment process, or water treatment chemical systems shall conform to ANSI/NSF 61 or its equivalent for international projects as applicable and shall be in accordance with policies governing the safety of public drinking water as stipulated by local, state, and federal statutes.

F. The units of measurement, range, and mounting configuration of each gauge shall be as indicated in the Gauge Schedule.

2.2 GAUGE ACCESSORIES

A. Isolation Valves

1. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Miscellaneous Ball Valves section.

B. Snubbers

1. Unless otherwise indicated, each pressure and compound pressure/vacuum gauge shall be provided with a pressure snubber. Each snubber shall be of internal or external design, fabricated of stainless steel, and of a size and pressure range compatible with the gauge served. Pressure snubbers shall be Operating and Maintenance Specialties "Ray Snubbers", Ashcroft "Pulsation Dampers", Weksler "Piston Type Pressure Snubbers", or Trerice "Pulsation Dampeners".

C. Gauge Isolators

1. Pipe-mounted Diaphragm Seals

   a. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge breakage or removal with the system under pressure. The lower housing shall be provided with a tapped 1/4 inch NPT flushing connection and an MxF stainless steel needle valve.
   b. Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Gauges shall be installed at the locations indicated on the Drawings. Installation configurations shall conform to the requirements of the Gauge Installation Details.

B. All gauges, snubbers and diaphragm seals shall be installed in the vertical upright position. Threaded connections shall be assembled using teflon thread tape or teflon thread sealer, as specified in the Miscellaneous Piping and Accessories Installation section. Teflon thread sealer shall not be used for liquid oxygen or oxygen gas piping. All connections shall be free from leaks.

C. Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.

End of Section

SECTION 40 74 00 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.

C. When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

D. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

F. Temperature instruments that come in contact with potable water, water in the drinking water treatment process, or water treatment chemical systems shall conform to ANSI/NSF 61 or its equivalent for international projects as applicable and shall be in accordance with policies governing the safety of public drinking water as stipulated by local, state, and federal statutes.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer.

One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 TEMPERATURE INSTRUMENTS

A. Resistance Temperature Detectors

1. Each temperature detector shall be a nominal 100 ohm, three or four wire, hermetically sealed, platinum resistance element. The sensing element shall be enclosed in an AISI Type 316 stainless steel outer sheath. Accuracy shall be ± 1°F over the specified operating range.

2. Each temperature detector shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule. The temperature element shall be spring-loaded in the thermowell. Appropriate temperature head hardware shall be provided with the assembly. Thermowells shall be manufactured by Ashcroft.

B. Resistance Temperature Transmitters

1. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output.

2. The transmitter shall be of the sensor lead wire compensated type with linearized output to provide an accuracy of ± 0.2 percent of temperature span. The transmitter shall be housed in a weatherproof enclosure designed for mounting directly on or near the thermowell. Shielded lead wire shall be provided as needed between the transmitter and the temperature detector. Each transmitter shall be coordinated with the sensor and thermowell. Transmitters shall be manufactured by ABB Model TTH300, or Rosemount "644/3144".

3. Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

4. Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

C. Temperature Switches

1. Temperature switches shall be ambient compensated, filled type, with integral sensor and thermowell. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual temperature. Switches shall be housed in EEMAC Type 4 enclosures. Switch wetted parts shall be compatible with the process fluid. Where the process fluid is not defined, the switch shall be provided with an AISI Type 316 stainless steel sensing element and an AISI Type 316 stainless steel thermowell.

2. All temperature switches shall be ranged in degrees Fahrenheit. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac.

3. Each switch shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule.

4. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All switches shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation.

5. Each switch shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or Instrument Device Schedule.

6. Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

7. Temperature switches shall be Ashcroft, or approved equal.

D. Temperature Gauges

1. Temperature gauges shall be of the indicating dial type, with a stainless steel bimetal thermometer and a stainless steel thermowell; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

2. Gauge dial shall be minimum 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

3. Panel-mounted and surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where indicated on the Drawings or the Instrument Device Schedule, stem mounted

gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

4. All temperature gauges shall measure in degrees Fahrenheit. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 1 percent of scale range.

5. Each gauge shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel.

6. Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All gauges shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation.

7. Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated on the Drawings or the Instrument Device Schedule.

8. Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

9. Temperature gauges shall be Ashcroft “EL Series, Code 60”, or approved equal.

PART 3 - EXECUTION

A. FIELD SERVICES

1. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

2. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 40 75 00 - PROCESS ANALYTICAL INSTRUMENTS

PART 1 - GENERAL.

1.1 SCOPE

A. This section covers the furnishing of all process liquid analytical instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

D. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Where possible, each instrument shall be factory calibrated to the calibration ranges on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or in the Instrument Device Schedule.

F. Analytical instruments that come in contact with potable water, water in the drinking water treatment process, or water treatment chemical systems shall conform to ANSI/NSF 61 or its equivalent for international projects as applicable and shall be in accordance with policies governing the safety of public drinking water as stipulated by local, state, and federal statutes.

1.3 SUBMITTALS

A. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in as specified in the Instrumentation and Control System section.

B. Cleaning

1. Instruments indicated to be utilized in oxygen, ozone, or similar service shall be cleaned for oxygen service, labeled appropriately, and bagged or packaged as necessary to ensure the instrument will remain suitable for insertion in the process during installation. Any special mounting or installation requirements associated with such instruments shall be detailed on tags attached to the instrument.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Drawings and/or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the

programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 11 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PROCESS LIQUID ANALYTICAL INSTRUMENTATION

A. Chlorine Residual Analyzers

1. Chlorine residual analyzers shall be the amperometric type and shall be provided with all required appurtenances shall be provided. For each type of analyzer supplied, a chlorine analyzer cleaning kit shall be provided. A one year supply of all consumables shall be provided along with the cleaning kit. Chlorine analyzers shall measure the free chlorine residual in a continuous flow sample as indicated on the Drawings or in the Instrument Device Schedule.

2. Sample Conditioning Panel

a. A sample conditioning panel shall be furnished and installed upstream of each chlorine residual analyzer as indicated on the Drawings.
b. Each sample conditioning panel shall be provided with an enclosure with a mini programmable logic controller (PLC) or timer for automatic sequential solenoid valve control. The PLC program or timer shall open the two-way solenoid flush valve for an adjustable time (5 minutes initially) to provide a high volume flow rate through the strainer. After an adjustable time duration (3.5 minutes initially) during the high volume flow rate, the three-way solenoid valve shall be energized for an adjustable time duration (1.5 minutes initially) to flush the analyzer sample control needle valve. When the flush valve and needle valve timers have expired, both solenoid flush valves shall close and return the analyzer sampling to normal.
c. Each strainer shall be transparent PVC bodied Y-pattern with 30-mesh screen, Viton O-ring seals, and socket ends. The blowoff from the strainer shall be equipped with the minimum 1/4" inch threaded connection and ball valve for bypassing excess sample flow to drain and for adjusting the pressure in the sample flow to the analyzer. The strainer shall be an Asahi/America Sediment Strainer or approved equal.
d. Solenoid valves type and construction shall be as follows:

Service	Water

Type	2-Way and 3-Way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or Teflon
Disc	Buna-N or Teflon
Stem	Manufacturer's standard
Bonnet Gasket	Manufacturer's standard
Spring	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32 to 104°F
Valve Operator	Integral
Manufacturers	ASCO "8210 Series" 2-Way and "8300 Series" 3-Way

e. Solenoid valves shall have packless construction without packing box or sliding seal.
f. Solenoid coils for ac service shall be encapsulated, Class F, for continuous duty at rated voltage ± 10 percent and 104°F ambient, in a NEMA Type 4 enclosure with a conduit knockout.

3. Amperometric Chlorine Residual Analyzers and Titrator

a. Amperometric chlorine residual analyzers shall be furnished to measure the free chlorine residual in a continuous flow sample.
b. The analyzers shall be of the amperometric or amperometric/polarographic type, with automatic sample temperature compensator, sample flow control, and self-cleaning electrode assembly for operation over an adjustable range between 0 to 50 or 0 to 20 mg/L of chlorine. Each analyzer shall consist of three electrodes which will generate electric current and constant potential for accurate readings.
c. Each analyzer shall operate with the following conditions:

Chlorine range, mg/L of chlorine	0 to 50 or 0 to 20
Analyzer accuracy	Residual levels below 20 mg/L: ±1% or 0.001 mg/L of chlorine, whichever is greater
	Residual levels below 60 mg/L: ±5% or 0.002 mg/L of chlorine, whichever is greater
Minimum required detection limit, mg/L chlorine	0.001
Sample water flow	De Nora: 2.4 gph

	Wallace & Tiernan: 1-2 gpm (potable); 3 to 5 gpm (wastewater)
Sample water pressure, psi	De Nora: 5 to 10 Wallace & Tiernan: 0 to 5

d. Each analyzer shall be furnished with the following accessories:
   1) Sample filter.
   2) Integral indicator calibrated 0 to 50 mg/L of chlorine.
   3) A 1 year supply of chemicals and expendable materials.
   4) Drain and overflow hose to bell-up.

e. Each analyzer instrument shall include a transmitter having a minimum of one 4-20 mA dc signal output. The analyzer shall be equipped with a minimum of three programmable relays to signal alarms. The analyzer shall operate using a 120 VAC, 60 Hz, single phase power supply.

f. The analyzer and electronics shall be installed in a wall panel for mounting. The electronics shall be enclosed in a NEMA 4X cabinet for protection. The analyzer dimensions shall not exceed 19 inches tall by 22 inches wide by 11 inches deep.

g. One amperometric titrator for measuring total or free residual shall be furnished for calibration of the chlorine residual analyzers. The titrator shall be complete with sample container, titrator solution bottle, pipettes, instruction book, chemicals, and other items required for proper operation. The titrator shall operate using a 120 volt, 60 Hz, single phase power supply.

h. The analyzer shall be De Nora Water Technologies “Series MicroChem CL1”, ATI Model “Q46H/79PR”, or Xylem/Wallace & Tiernan “Micro/2000”. The titrator shall be Evoqua Water Technologies/Wallace & Tiernan “Series A-790” or approved equal.

B. Dissolved Oxygen Analyzers

1. An optical type dissolve oxygen analyzer shall be provided. The principle of operation shall be based on the time measured from excitation of a luminescent material by a light source to the time light is emitted by the material. The luminescent material shall be mounted to an oxygen permeable replaceable cap fitted over the end of the probe. The probe shall be submersible and supplied with 30 ft of cable or a length of cable as otherwise indicate in the Instrument Device Schedule. The probe shall be provided with an automatic air blast cleaning system, complete with all required accessories and a compressor system contained in NEMA 4X enclosure. The compressor motor shall be 120 volt, single phase.

2. The transmitter shall be enclosed in a NEMA Type 4X enclosure with mounting brackets for surface or pipe mounting. The transmitter shall be of the ac-powered type. The transmitter shall have a local LCD display calibrated to read 0 to 20 ppm and shall have a corresponding 4-20 mA dc output signal capable of driving a 0 to 600 ohm external load. The transmitter and probe shall be furnished with all mounting hardware. The probe shall be the Hach LDO Model 2 probe with SC4500 controller or Endress + Hauser Oxymax COS61D probe with Liquiline CM442 transmitter.

3. A membrane type analyzer shall be provided, having a galvanic or polarographic type (Ross or Clark principle) dissolved oxygen sensor. The sensor shall include a field replaceable cartridge assembly with pre-installed membrane, electrolyte, and electrodes that is disposable. The electrode chamber shall be isolated from the process by an oxygen-permeable (liquid-impermeable) membrane. A one-year supply of replacement membranes and electrolyte shall be provided. The sensor probe assembly shall be immersion type, with integral automatic temperature compensation over a range of 0 to 122°F. The sensor shall be insensitive to varying hydraulic heads up to a depth of 100 ft. The sensor shall be provided with an automatic air blast cleaning system, with compressor system contained in NEMA 4X enclosure. The compressor motor shall be 120 volt, single phase.

4. The dissolved oxygen transmitter shall be of the microprocessor type, with non-volatile memory, and built in diagnostics. The transmitter shall display the reading on an integral indicator and shall transmit an isolated 4-20 mA dc signal proportional to the amount of dissolved oxygen. The transmitter shall be of the ac-powered type. The transmitter shall be housed in a NEMA Type 4X enclosure and shall be suitable for surface or pipe mounting. The ambient temperature rating shall be -4°F to 140°F, with integral heater.

5. The dissolved oxygen analyzer (membrane type) shall be manufactured by Hach, YSI, or equal.

C. pH and ORP Analyzers

1. The pH or ORP sensor and analyzer/transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor shall consist of a kynar, PVC, polypropylene, or other chemical-resistant electrode housing containing a glass pH electrode and a fouling-resistant reference electrode, or gold/platinum ORP electrodes. The pH reference electrode shall be self-contained and shall not require an external electrolyte reservoir. The sensor shall have automatic temperature compensation and shall be the flow-through type or submersion type as indicated on the Drawings..

2. Flow-through type sensors, shall have 3/4 or 1 inch NPT process connections and shall be suitable for a working pressure of 1 to 100 psig at 140°F, with a sample flow rate of 0.5 gpm.

3. Submersion type sensors, shall be suitable for submersion in 30 feet of water at temperatures of 32 to 140°F. A protection shroud shall be provided to protect the electrode. The cable and cable entrance to the sensor shall be suitable for submersible applications.

4. Each pH sensor assembly shall be provided with a maintenance kit that shall include a spare pH electrode, a spare reference electrode, and other spare parts as recommended by the manufacturer.

5. The transmitter shall be enclosed in a cast aluminum or fiberglass reinforced plastic NEMA Type 4 housing. The transmitter shall be microprocessor based, with integral diagnostics, and with non-volatile memory. The transmitter shall be suitable for ambient

temperatures of -22 to 140°F and a relative humidity of 0 to 100 percent. The transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 0.2 percent of scale. The transmitter shall have a 32-character alphanumeric multiline LCD display that is menu driven. Transmitter range shall be as indicated. The transmitter shall have automatic temperature compensation over a range of 32 to 122°F. The transmitter shall be of the ac-powered type. The transmitter shall be supplied with an appropriate length of signal cable for connecting the transmitter to the sensor.

6. The pH analyzer shall be manufactured by Electro-Chemical Devices, Schneider Electric, GLI/Hach, ABB, or Rosemount.

D. Alkalinity Analyzers

1. The alkalinity analyzer shall be an online, automatic wet-chemistry analyzer designed for continuous measurement of total alkalinity in wastewater effluent. The analyzer shall automatically perform sample collection, reagent addition, titration, measurement, and result calculation without operator intervention.

2. The analyzer shall measure alkalinity utilizing an automatic acid titration method and shall provide measurement in mg/L as CaCO3. The analyzer shall be suitable for continuous monitoring of treated wastewater effluent downstream of the chlorine contact basin and upstream of the outfall discharge point.

3. The analyzer shall operate with the following minimum performance requirements:

   a. Measurement range: 0 to 500 mg/L as CaCO3, field adjustable.
   b. Accuracy: ± 5 percent of measured value or better.
   c. Repeatability: ± 2 percent of measured value or better.
   d. Response Time: One complete analysis cycle every 10 minutes or less.
   e. Sample Temperature: 32 Deg F to 104 Deg F.

4. The analyzer The analyzer shall be furnished complete with all accessories required for operation, including sample conditioning components, reagent containers, tubing assemblies, calibration materials, mounting hardware, and waste collection system.

5. The analyzer shall include automatic calibration and diagnostic functions. The analyzer shall generate local diagnostic alarms for reagent depletion, sample flow failure, instrument fault, calibration failure, and communication failure.

6. The analyzer transmitter/controller shall be microprocessor based and supplied in a NEMA Type 4X enclosure suitable for wall mounting. The analyzer shall include a local graphic display indicating measured alkalinity, alarm conditions, diagnostic messages, and calibration status.

7. The analyzer shall provide a minimum of one isolated 4-20 mA output signal proportional to measured alkalinity and shall be capable of Modbus TCP/IP or Ethernet communications as required by the Instrumentation and Control System.

8. The analyzer shall operate on 120 VAC, 60 Hz, single-phase power.

9. One year supply of reagents, standards, consumables, tubing, and maintenance parts required for continuous operation shall be furnished with each analyzer.

10. The analyzer shall be suitable for connection to PLC-4000 and shall provide continuous alkalinity measurement for operator monitoring, process trending, and reporting through the SCADA system.

11. The alkalinity analyzer shall be Hach EZ Series Alkalinity Analyzer with SC4500 Controller or approved equal.

PART 3 - EXECUTION

3.1 Field Services

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 43 05 41 - CHEMICAL STORAGE TANK INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers installation of tanks for aboveground bulk storage of chemical solutions.

B. Tanks, piping, pipe supports, valves, and accessories which are not an integral part of the tanks are covered in other sections.

1.2 GENERAL

A. Coordination

1. The tanks are to be installed in areas of limited access. The timing of installation for the tanks shall be coordinated with building construction and with construction under other contracts as needed.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 Not applicable.

PART 3 - EXECUTION

3.1 INSPECTION

A. All equipment and accessories shall be inspected for damage and cleanliness before being installed. Any item damaged or contaminated in handling on the job shall not be used unless it has been repaired and re-cleaned to the original requirements by Contractor. Such items shall be segregated from clean or undamaged items and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION

A. The concrete base for each tank shall be constructed in accordance with the Cast-in-Place Concrete section and shall be level and smooth to the tolerances recommended by the tank manufacturer.

3.3 INSTALLATION

A. When the tank containment area has a corrosion protection system specified, the protection system shall be applied and cured to the tank base before each tank is installed. Each tank shall be installed in accordance with the tank manufacturer's recommendations, the applicable governing standard, and to the satisfaction of Engineer. At any location where a containment corrosion protection system lining is penetrated including anchorage of a tank, a caulking material suitable for the specified service conditions and recommended by the protection system manufacturer shall used to seal around the penetration. Grouting under the tank, if recommended by the tank manufacturer, shall be accomplished with nonshrinking grout as specified in the Grouting section.

3.4 FIELD QUALITY CONTROL

A. Lining Testing

1. When a corrosion resistant lining is specified, the liner shall be tested after installation for damage occurring during installation. The lining shall be tested for holidays and pinholes using a low-voltage unit holiday detector approved by the coating manufacturer and acceptable to Engineer. Locations where holidays and pinholes are detected shall be marked for repair and retested after repair work has been completed. Contractor shall certify the lining is free of holidays and pinholes.

2. Leakage Testing

a. After installation and testing of any lining, each tank shall be filled with water to the level required and allowed to stand for a period of not less than 48 hours. During testing, flanged connections may be plugged by installing temporary blind flanges on the outside of the tank, but shall not be blocked or plugged on the inside. All leaks or indication of leaks shall be repaired by the tank manufacturer and the tank re-tested to the satisfaction of Engineer.

3.5 CLEANING

A. When installation and testing have been completed and all connections have been made, all tank surfaces, both interior and exterior, shall be thoroughly cleaned as recommended by the tank manufacturer and to the satisfaction of Engineer. Abrasive cleaning agents shall not be used.

End of Section

SECTION 43 24 13 - VERTICAL DIFFUSION VANE PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of vertical diffusion vane pumping units as indicated herein:

Pump designation.	Cooling Water Pump No. 1 Cooling Water Pump No. 2
Number of pumps.	2
Pump tag numbers.	COLW-PVT-1510 COLW-PVT-1520
Pump location.	Widows Creek Pump Station

B. Each pumping unit shall be complete with a pump, electric motor, pedestal, sub-base, anchor bolts, and all other appurtenances specified or required for proper operation.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Governing Standard

1. Except as modified or supplemented herein, all vertical diffusion vane pumps shall conform to the applicable requirements of ANSI/AWWA E103 and the Hydraulic Institute Standards.

E. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

F. Power Supply

1. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

G. Identification

1. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each pumping unit shall include, but shall not be limited to, the following:

a. Pumps
   1) Name of manufacturer.
   2) Type and model.
   3) Design rotative speed.
   4) Diameter of discharge outlet.
   5) Diameter of line shafting.
   6) Type of lineshaft bearings.
   7) Diameter and wall thickness of pump column.
   8) Number of stages.
   9) Type of bowl bearings.
   10) Complete performance curves showing capacity versus head, NPSH required, pump efficiency, and bhp [brake kW] plotted to scales consistent with performance requirements.
   11) OD of pump bowls.
   12) Weight including bowls, column, and pedestal
   13) Diameter and wall thickness of pump barrel.
   14) Diameter of suction flange.

b. Complete Pumping Unit
   1) Max overall dimensions.
   2) Total weight including motor and base plate.
   3) Data on shop painting.

c. Motors

1) As specified in the Common Motor Requirements for Process Equipment section.

d. Adjustable Frequency Drives
1) As specified in the Adjustable Frequency Drives section.

e. Seismic Design Requirements
1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

A. Balance

1. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the pump shall not exceed the maximum vibration limit of the governing standard unless otherwise required. The unfiltered vibration velocity, as measured at the top of the motor, shall not exceed 150 percent of the limit of the governing standard.

2. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1.5 SPARE PARTS AND ACCESSORIES

A. Spare parts shall be suitably packaged, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed. The following spare parts shall be furnished.

Spare Part	Quantity
Mechanical seals	1 set
Bowl wearing rings	1
Impeller wearing rings	1
Sets of bowl bearings	1
Sets of lineshaft bearings	1

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The pumping units shall be suitable for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section	
Type of environmental exposure.	Indoor	
Ambient air temperature range.	40 to 104	° F
Liquid temperature range.	60 to 104	° F
Solids concentration, percent by weight.	___	%
Pumps start and stop against a closed valve.	No	
Site elevation.	See Meteorological and Seismic Design Criteria section	
Units subject to freezing temperatures.	No	
Size of solids	___	in
Crane facilities available.	No	

B. Parts shall be interchangeable between units of similar size and capacity to extent practical.

C. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Pumping units shall be designed for the following performance and design requirements, at maximum speed unless otherwise noted:

Pump tag numbers.	COLW-PVT-1510 COLW-PVT-1520	
Rated head.	246	ft
Capacity at rated head.	700	gpm
Operating head range for full speed continuous operation.	250 *to* 220	ft
Maximum nominal pump speed.	1800	rpm

Minimum head at reduced speed.	180	ft	
Capacity at minimum head and reduced speed.	350	gpm	
Approximate minimum pump speed, as percent of maximum.	70	%	]
Maximum power required at pump input shaft at any point in the operating range.	68	bhp	
Efficiency.	73	%	
Type of efficiency indicated.	Pump		
Efficiency calculated at.	Rated head		
Pump designed for reverse rotation.	No		
Maximum “A” rated weighted noise at 3 ft [1 m].	_____	dBa	
Maximum unfiltered vibration velocity.	HIS	in/s	
Minimum nominal size of pump column.	8	in	
[Minimum NPSHA at the suction flange at rated head.	34.8	ft	
Minimum ratio of NPSHA to NPSHR.	1.3		
[Nominal submergence range above wetwell floor (for wetwell mounted pumps).	4 to 8	ft	
Vertical distance from wetwell floor to center line of above floor discharge (for wetwell mounted pumps).	33.09	ft	
Maximum vertical distance from center line of above floor discharge to bottom of sub-base (for wetwell mounted pumps).	32.30	ft	]
Maximum vertical distance from center line of above floor discharge to bottom of sub-base (for wetwell mounted pumps).	0.80	ft	

1. Minimum shop test pressure on bowl assembly shall be 1.5 times the shutoff head plus maximum suction pressure where applicable.

2. The pump setting shall be as indicated on Drawings.

3. For design and rating purposes, the water to be pumped shall be assumed to have a temperature of 85° F .

4. Pump performance shall be stable and free from damaging cavitation, vibration, and noise in the operating head range. The performance of pumps with an enclosed impeller shall be based on a radial running clearance between the bowl wearing ring and the impeller of not less than 6 mils , or 0.5 mil per inch of wearing ring diameter, whichever is greater.

2.3 Approved Manufacturers

A. Pumps shall be designed such that the entire flow range from rated capacity at rated head down to capacity at minimum head and reduced speed is within the Preferred Operating Region as defined by API 610.

B. The following pump manufacturer models and configurations are approved for this application: (or equal)

Manufacturer	**Model/Size**	**Number of Stages**	**Nominal rpm**
Sulzer	JTS-11LC	6	1800
Xylem/Goulds	11CLC	5	1800
Patterson	12 DMC	6	1800

C. Models listed as approved must meet all parameters specified herein.

2.4 MATERIALS

Suction Strainer	Stainless steel
Pump Bowls	Cast iron, ASTM A48, Class 30.
Impellers	Aluminium Bronze, ASTM B148-952.
Bowl Wearing Rings	Bronze, ASTM B505 – 927**]**
Impeller Wearing Rings	Bronze, ASTM B505 – 932
Bowl Assembly Shaft	Martensitic stainless steel, AISI Type 410 or 416.
Bowl Bearings	Bronze, ASTM B505-932, water lubricated, except suction case (bowl) bearing shall be permanently packed with water-resistant grease.
[Lineshaft, stainless steel	Martensitic stainless steel shaft, AISI Type 410 or 416, with Martensitic stainless steel couplings of dissimilar alloy.
Open Lineshaft Bearings	Goodrich "Cutless Rubber", water lubricated.

Lineshaft Bearing Retainer	Bronze, ASTM B584; ductile iron; or Carbon steel if integral with column.
Threaded Pump Column	ASTM A53, Grade A standard weight steel pipe, with threaded couplings.
Flanged Pump Column	AWWA C200 steel pipe at least 3/8 inch thick, with flanged couplings.
Stuffing Box Housing	Cast iron, ASTM A48, Class 30.
Stuffing Box Bearing	Bronze, ASTM B505-932, water, internallubricated.
Stuffing Box Hardware	Corrosion-resistant metal.
Mechanical Seal	Single one piece balanced cartridge type; John Crane, Durametallic, Chesterton, or equal.
Water Slinger	Rubber or bronze.
Pedestal and Subbase	Cast iron or fabricated steel.
Pipe Thread Lubricant	Teflon paste type thread sealer suitable for potable water service where required.
Lineshaft Coupling Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti-Seize".
Epoxy Coating	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".

2.5 PUMP CONSTRUCTION

A. Each pump shall be the turbine or mixed flow type suitable for wetpit installation.

B. Suction Bowl Inlet

1. Wetpit pumps shall be equipped with a flared suction bowl inlet and a suction strainer. Net opening of the suction strainer shall be at least 2-1/2 times the inlet area of the pump.

2. Pumps shall be provided with an anti-vortex vane grating basket. The basket shall be fabricated as shown in the Drawings.

C. Impellers and Bowls

1. Impellers shall be accurately machined, dynamically balanced, and securely locked on the pump shaft. Impellers shall be enclosed.

2. Balance rings which depend upon close running clearances to reduce the load on the drive unit thrust bearing will not be acceptable unless otherwise indicated.

3. Pump bowls and impellers shall be equipped with wearing rings designed to maintain pump efficiency. Wearing rings shall be securely locked in place so that they will not move or loosen during any condition of operation or handling, including reverse rotation of the pump.

D. Shafting

1. All pump shafting shall conform to the applicable sections of the governing standard. Shaft diameter shall be not less than the minimum permitted for the applicable driver nameplate power rating. Shafting shall be open.

E. Shaft Couplings

1. Shaft couplings shall transmit the maximum combination of torque and thrust and shall maintain alignment between adjacent shaft sections. Couplings shall be threaded type.

2. During assembly, anti-seize thread lubricant shall be applied to male threads of all threaded connections.

3. Keyed, sleeve, or split type couplings shall have split thrust rings at the ends of the shafts. The joint shall be easily assembled and disassembled.

F. Bearing Retainers

1. Open lineshaft pumps shall have bearings mounted in streamlined spiders supported by the column assembly. Rubber bearings shall be positively held in place by shoulders, retainer rings, or other mechanical means.

G. Pump Column

1. Pump column sections shall be so designed and constructed that accurate alignment will be obtained when the column is assembled. The type of couplings shall be threaded or flanged.

2. The pump column shall be long enough to locate the suction inlet a distance of at least equal to 1/3 times the bell diameter, but not more than 3/4 times the bell diameter above the wetwell floor.

H. Lineshaft Stuffing Box

1. Ahigh pressure stuffing box shall be provided at the top of the pump pedestal for sealing the lineshaft entry point.

2. The stuffing box shall be provided with a single mechanical seal suitable for vertical turbine pump service.

I. Pedestal

1. Each pump pedestal shall be designed to support the drive unit and the entire pump assembly. Suitable openings shall be provided for access to the stuffing box and other accessories. A registered connection or dowels shall be provided between the motor and the pedestal. The tolerance of the registered fit shall be less than the stuffing box bearing tolerance so that when installed the shaft will not touch the stuffing box bearing. A suitable stuffing box leakage collector with a 1/2 inch tapped drain opening shall be provided. Each pocket shall have a drain connection.

J. Pump Discharge Outlets

1. Pump discharge outlets may have flanged ends. The pump discharge outlet shall be integral with the pedestal. The pump discharge outlet shall be above the floor.

2. The diameter and drilling of the flange shall conform to ANSI/ASME B16.1, Class 125.

3. Plain ends shall conform to Section 3.6 of AWWA C200 and shall be equipped with harness lugs suitable for use with a mechanical sleeve type coupling. The outside diameter of the pump discharge shall be compatible with the connecting piping. Discharge outlet wall thickness and harness lugs shall conform to Figure 13-20, Type RR and Table 13-5 of AWWA Manual of Water Supply Practices, M11, third edition, "Steel Pipe - A Guide for Design and Installation". Unless otherwise indicated on the Drawings, the number and size of the tie rods shall be based on equal area of tie rods to the area of the pipe wall of the connecting pipe.

4. A 1/2 inch NPT tapped and plugged pressure gauge connection shall be provided on the horizontal center line of the pump discharge outlet. The size and configuration of the connection shall conform to Figure A.6 of the Hydraulic Institute Standard 14.6.

K. Subbase

1. A rigid subbase with rounded corners shall be provided to support each pedestal. Abutting surfaces between the subbase and the pedestal shall be machined to provide uniform bearing.

2. Each subbase shall have a center opening large enough to permit withdrawal of the entire pump assembly.

L. Shop Painting

1. All iron and steel parts which will be in contact with pumped liquid or submerged after installation, including the inside of the pump column and all exterior surfaces below the subbase plate or mounting flange, shall be shop cleaned by blasting in accordance with the coating manufacturer's recommendations and painted with an epoxy coating system. The coating shall

have a dry film thickness of at least 10 mils and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart of the finish material shall be furnished with each pump for field touchup.

2. All other iron and steel surfaces, except stainless steel and machined surfaces, shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an epoxy or polyurethane enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

3. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

2.6 ACCESSORIES

2.7 DRIVE UNITS

A. Electric Motors

1. Electric motors shall be designed as specified in the Common Motor Requirements for Process Equipment section.

2. Motor shaft shall be hollow type.

3. For hollow shaft motors, an adjusting nut shall be provided at the top of the motor for raising or lowering the shafting to properly center the impellers in the bowls. When required, a coupling shall be provided in the shafting below the motor to permit removal of the motor without lifting it over the shaft.

4. Where mechanical seals are specified, the adjustable coupling shall be spacer type to permit removal of the mechanical seal without disturbing the motor.

5. If the motor is not shop tested with the pump, certified motor efficiency data shall be furnished to the pump supplier based on tests conducted on the motor or on an identical motor.

B. Adjustable Frequency Drives

1. Each pump shall be furnished with an adjustable frequency drive. The design of each adjustable frequency drive shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing the

adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

2. Adjustable frequency drives shall be designed as specified in the Adjustable Frequency Drives section.

2.8 SHOP TESTS

A. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Table 14.6.3.4 Grade 1U, with no minus tolerance or margin allowed.

B. For pumping units with bearings that require cooling water, the parameters of cooling water such as flow rate, inlet water temperature and outlet water temperature, bearing frame external temperature and bearing race temperature (RTD) shall be measured, recorded, and reported as part of the test.

C. Each pumping unit shall be shop tested with the motor to be installed in the work. When tested with the job motor at full speed, the final certified test curves shall not include any speed corrections.

D. For pumping units under 100 horsepower , a certified performance curve including head, pump input power, pump efficiency, and wire-to-water efficiency shall be prepared by the pump manufacturer. Five copies of the certified curve shall be delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory.

E. When the pump is not tested at the rated speed, performance charts shall include both the test speed and the calculated speed curves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each pump shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

B. The equipment base shall be grouted before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange

bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

End of Section

SECTION 43 41 45.13 - FIBERGLASS REINFORCED PLASTIC CHEMICAL STORAGE TANKS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of tanks fabricated of fiberglass reinforced plastic and intended for aboveground bulk storage of chemical solutions as indicated herein.

B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall coordinate the work between the suppliers of equipment to be used with or connected to the storage tanks to ensure that all required provisions for mounting the accessories and connecting piping are included.

2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, materials and construction methods shall conform with the applicable provisions of the following standards:

Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment, ASTM C582.

Standard Specification for Filament-Wound Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks, ASTM D3299.

Standard Specification for Contact-Molded Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks, ASTM D4097.

F. Nameplates

1. Each tank shall be provided with a nameplate. The nameplates shall be of white phenolic material with black engraved lettering 3 inches high, and shall be mounted on the tank straight shell. The chemical name and the tank tag number indicated on the Tank Data Sheet shall be engraved on the nameplate.

G. Certification Plates

1. A stainless steel certification plate shall be mounted a maximum of four feet above the tank bottom on the side of each storage tank. Bracketed flat surfaces shall be provided on the tank for installation of nameplate and certification plate.

2. At least the following data shall be included on the certification plate:

Name of tank fabricator.

Date of manufacture.

Manufacturer’s serial number.

Resin designation for entire tank (structural and corrosion barrier).

Maximum allowable concentration and temperature of the specified chemical solution that can be stored safely.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications covering the storage tanks, connections, and accessories shall be submitted in accordance with the Submittals Procedures section.

2. The data shall include full information on all tank fabrication materials and test data confirming the chemical resistance of the proposed resins to the intended tank contents.

3. Drawings shall include a profile diagram of the entire tank wall resin system indicating the thickness, resin designation, reinforcement, and surfacing matt material of each layer including the structural and corrosion barrier layers.

4. The data shall also indicate the sizes of all major tank components; size, spacing, and design loading of supporting saddles; anchor bolt locations and details; and full information and details concerning field assembly and installation.

5. A total of three cutouts from each tank shall be provided and shipped with and attached to the associated tank. The cutouts shall consist of one from the roof and two from the tank wall. The cutouts shall be from any of the tank connections with a diameter of 2 inches or larger.

6. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section and the manufacturer's recommendations. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section and the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Each tank shall be designed for storage of the chemical or chemicals at the design conditions specified in the attached Tank Data Sheet(s).

B. Useable capacity shall be measured from the invert of the tank overflow nozzle to the top of the pump suction nozzle.

C. Vertical tanks shall be vertical cylinders with a bottom and top constructed as specified herein. Horizontal tanks shall be a horizontal cylinder with flat or dished heads and supported on saddles. Tanks shall be provided with a suitable overflow connection. Tanks shall be vented and will normally be used to store the specified chemical at atmospheric pressure, but shall be designed to withstand the hydrostatic head resulting from the tank being surcharged to 6 inches above the top of the tank.

D. Design criteria for calculating wind, snow and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. <u>Tank Bases</u>

1. Unless otherwise indicated or specified, all tanks shall be installed on concrete bases at least 6 inches high. The tanks shall be anchored to the concrete base with suitable anchor bolts.

2.2 RECOMMENDED MANUFACTURERS

A. Recommended manufacturers shall be as specified in the Tank Data Sheet.

2.3 MATERIALS.

Resin	Bisphenol-A polyester or vinyl ester resins suitable for use with the specified chemical as recommended by the resin manufacturer.
Reinforcement	Boron free E-CR glass for mat, woven roving and roving for filament winding.
Surfacing Mat	Nexus veil by Precision Fabrics Group.
Plastic Laminate	In conformity with the applicable governing standards.

A. Also reference the attached Tank Data Sheet(s) for additional materials requirements.

2.4 CONSTRUCTION

A. The tanks shall be of hand lay-up, spray-up, or filament-wound construction in accordance with the applicable governing standard. The entire tank, structural and corrosion barrier, shall be constructed of a single generic type of thermoset resin and shall not contain colorants, dyes, fillers, or pigments unless otherwise specified. Ultraviolet absorber shall be added to the resin used in the fabrication of tanks indicated in the Tank Data Sheet(s) for installation in outdoor locations.

B. The inner surface layer of sodium hypochlorite and the hydrofluosilicic acid tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 120 mils. The surface of the corrosion barrier exposed directly to the corrosive chemical shall consist of a two-ply surfacing veil with a minimum thickness of 20 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

C. The inner surface layer of hydrochloric acid tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 200 mils. The surface of the corrosion barrier exposed directly to the corrosive chemical shall consist of a two-ply surfacing veil with a minimum thickness of 20 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

D. The inner surface layer of all other tanks shall consist of a resin rich corrosion barrier with a minimum thickness of 110 mils. The surface of the corrosion barrier exposed directly to the

corrosive chemical shall consist of a singly-ply surfacing veil with a minimum thickness of 10 mils. The remainder of the corrosion barrier shall consist of two layers or more of chopped strand mat or equivalent.

E. Sodium hypochlorite tanks shall be catalyzed with a benzoyl peroxide/dimethyl aniline (BPO/DMA) catalyst system. Each tank shall undergo a four hour dry oven post-cure at a minimum temperature of 180° F after fabrication per the resin manufacturer's recommendation. Use of thixotropic resin additives will not be allowed. Alternative catalyst systems will be considered if written confirmation from the resin manufacturer verifying the effectiveness of the proposed system is provided.

F. When a vertical tank with removable top is required, the tank shall be provided with an outward projecting stiffening flange for connection of the removable top. A chemical resistant elastomeric gasket and assembly bolts shall be furnished for attachment of the top.

G. When a vertical tank with a flat or closed top is required, the top of the tank shall be reinforced as specified in the applicable governing standard. Additional reinforcement shall be provided as necessary to support the required accessories and personnel loads. Tank roofs shall be provided with nonskid strips or a nonslip finish over the entire roof surface.

H. The tank shall be provided with the appropriate number and size of lifting lugs for handling and installation and hold-down lugs for anchoring the tank to the concrete base.

2.5 ACCESSORIES

A. Special Tools and Accessories

1. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

B. Access Manways

1. Access manways shall have a nominal diameter of 24 inches. The number and location of access manways on the tank shall be as indicated in the Tank Nozzle Schedule. Each manway shall be flanged, fully gasketed, and furnished with a fabricated blind flange having the same properties as the tank wall laminate. Flange diameter and drilling shall conform to (ANSI B16.5, Class 150) ASTM D3299 Table 5. Side access manways shall be centered approximately 3 feet above the bottom of the tank.

C. Hinged Covers

1. When hinged covers are specified in the Tank Data Sheet, tanks shall be provided with half of the top hinged for access to the interior. The inactive half shall be bolted to the tank shell. The active half shall be hinged from the inactive half, shall be provided with a lifting handle, and shall be suitably supported on the tank shell when closed. The hinge shall be fabricated of AISI Type 316 stainless steel or chemically-resistant plastic.

D. Flanged Nozzles

1. Nozzles for connecting piping and accessories shall be provided on each tank at the locations and of the sizes as indicated in the Tank Data Sheet.

2. Each nozzle shall be flanged, with flange diameter and drilling conforming to ANSI B16.5, Class 150. Nozzles shall extend at least 4 inches from outside face of tank to face of flange.

3. Flanged nozzles shall be fabricated of the same material as the tank and shall be gusseted to the tank or otherwise reinforced in accordance with the governing standard.

4. The mounting flange for ultrasonic type transmitters shall be not less than 18 inches above the maximum liquid level. The center line of the nozzle shall be at least 24 inches from the tank sidewall, fill nozzle, and other obstructions.

5. Nozzles for drain connections shall be installed so the invert is flush with or lower than the bottom of the tank to allow complete draining of the tank.

E. Vents

1. The tank shall be provided with a vent of the size recommended by the manufacturer, but not less that the size indicated on the Tank Nozzle Schedule, to prevent pressurizing the tank during filling or drawing a vacuum inside the tank during pumping or draining. The vent shall be as specified in the Tank Data Sheet.

F. Ladders and Handrail

1. When specified in the Tank Data Sheet, tanks shall be provided with an exterior ladder. The ladder shall be supported on and anchored to the concrete base and bracketed to the tank shell as needed. When specified in the Tank Data Sheet, safety handrails and kickplates meeting current OSHA requirements shall be provided around the top of each tank. The handrail shall be attached to the ladder siderails and anchored to the tank head. A self closing safety gate shall be provided at the ladder access opening. The ladder shall be fabricated of fiberglass reinforced plastic shapes, stainless steel, aluminum, or carbon steel completely coated with at least 1/8 inch of reinforced resin after fabrication. Uncoated or exposed carbon steel parts or fasteners will not be acceptable. The ladder shall have a clear width of at least 16 inches, with rungs at least 3/4 inch in diameter and spaced not more than 12 inches apart, and a clearance of at least 7 inches between the back of the ladder and the tank wall.

2. Ladder Fall Protection System

a. Each tank with a total height of 12 or more feet above the finished floor shall be provided with a fall protection system. The fall protection system shall be installed directly on the ladder and constructed of stainless steel or other corrosion resistant materials where available. The fall protection system shall be provided with the appropriate number of cable guides as recommended by the system manufacturer, and one full body safety harness rated for not less than 300 pounds. When fall

protection for outdoor tanks is specified, the storage tank vent shall be discharged 180 degrees from the ladder. Fall protection system shall be Capital Safety "Lad-Safe" or approved equal.

G. Sight Level Gauge

1. Each tank shall be provided with a sight level gauge. The gauges shall be clear type or magnetic flag type, as specified in the Tank Data Sheet.

2. Clear Type Level Gauge

a. When specified in the Tank Data Sheet, a chemical-resistant valve and gauge tube assembly shall be mounted on the tank. The exterior tube of the gauge tube shall be fabricated of 1 inch diameter clear PVC, polycarbonate, or borosilicate glass. The interior wetted tube shall be clear PFA Teflon or other material, as specified. An epoxy coated steel or fiberglass shield which does not obstruct the gauge shall be provided the full length of the gauge. Alternatively, the gauge tube shall be fabricated of 1 inch diameter FEP (Fluorinated Ethylene Propylene) with flair through flange end connections. The FEP gauge tube shall have a wall thickness of 0.1 inch and the flanges shall be epoxy-coated ductile iron. A graduation strip shall be mounted adjacent to or integral with the sight level gauge. The strip shall run the full length of the level gauge and shall be graduated in gallons using 1 inch high black lettering over a range from zero gallons to the rated capacity of the tank. The gauge tube assembly shall be Jogler Inc. Model ULSS, Pureflex Inc. Model Puresite, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment furnished under this section shall be installed in accordance with the Chemical Storage Tank Installation section.

End of Section

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SECTION 43 41 45 13-DS01 - FIBERGLASS REINFORCED PLASTIC CHEMICAL STORAGE TANKS

Tank Data Sheet – Sodium Bisulfite		
General		
	Chemical service.	Sodium Bisulfite
	P&ID drawing reference.	I-40-605
	Tank tag number(s).	NHS-TNK-4201
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	38%
	Maximum specific gravity.	1.34
	Maximum temperature.	120° F
	Installed location.	Indoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity.	5,000 Gal
	Tank diameter.	9 ft
	Straight shell length/height.	11.5 ft
	Maximum total length/height.	13 ft
	Recommended manufacturers.	Augusta Fiberglass, Belding Tank Technologies, Belco, Diamond Fiberglass
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	Yes
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	ASTM A36 Carbon Steel with fiberglass reinforced coating
	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2

	Gaskets.	EDPM		
Accessories				
	Tank vent.	Connect to vent piping system		
	Ladder required.	Yes		
	Handrail required.	Yes		
	Sight level gauge.	Clear type		
	Material for clear type, exterior tube.	Clear PVC		
	Material for clear type, interior wetted tube.	PVC		
	Drawings for nozzle orientation.	M-40-101		
Tank Nozzle Schedule				
	Quantity	Connection	Location	Size (in)
	1	Tank fill.	Top	2
	1	Pump suction.	Side bottom	2
	1	Drain.	Side bottom	2
	2	Level gauge.	Side top and bottom	2
	1	Overflow.	Side top	3
	1	Vent.	Top	4
	2	Manway.	Top, side bottom	24
	1	Level sensor.	Top	8

Tank Data Sheet – Sodium Hypochlorite		
General		
	Chemical service.	Sodium Hypochlorite
	P&ID drawing reference.	I-40-603
	Tank tag number(s).	NOCL-TNK-4101
	Number of tanks.	1
Design Requirements		
	Chemical concentration, percent by weight.	12.5%
	Maximum specific gravity.	1.175
	Maximum temperature.	120 °F
	Installed location.	Indoor
	Tank configuration.	Vertical cylindrical
	Tank bottom.	Flat
	Tank top.	Domed
	Usable capacity.	10,000 Gal
	Tank diameter.	12 ft
	Straight shell length/height.	12 ft
	Maximum total length/height.	14 ft
	Recommended manufacturers.	Augusta Fiberglass, Belding Tank Technologies, Belco, Diamond Fiberglass
	Tank insulation required.	No
	Tank heating required.	No
	Protective coating required for metal parts.	Yes
Materials		
	Exposed metal.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Protected metal.	ASTM A36 Carbon Steel with fiberglass reinforced coating

	Assembly bolts, nuts, and washers.	Stainless steel, ASTM F593, Alloy Group 1 or 2, ASTM F594, Alloy Group 1 or 2
	Gaskets.	Viton (FKP)
Accessories		
	Tank vent.	Connect to vent piping system
	Ladder required.	Yes
	Handrail required.	Yes
	Sight level gauge.	Clear type
	Material for clear type, exterior tube.	Clear PVC
	Material for clear type, interior wetted tube.	FEP
	Drawings for nozzle orientation.	M-40-101

Tank Nozzle Schedule

	Quantity	Connection	Location	Size (in)
	1	Tank fill.	Top	2
	1	Pump suction.	Side bottom	2
	1	Drain.	Side bottom	2
	2	Level gauge.	Side top and bottom	2
	1	Overflow.	Side top	3
	1	Vent.	Top	6
	2	Manway.	Top, side bottom	24
	1	Level sensor.	Top	8

SECTION 43 42 41.10 - HYDROPNEUMATIC BLADDER TANK

PART 1 - GENERAL

1.1 SCOPE

A. This section covers a vertical steel pressure vessel, bladder, nozzles, supports and accessories to be provided as indicated on the piping and instrumentations diagrams (P&ID) or otherwise required.

Service.	Cooling Water
P&ID drawing reference.	I-15-601
Tank tag numbers.	COLW-TNK-1550

B. The vessel shall be used to control surge pressures in the cooling water force main downstream of the Widows Creek Pump Station. The vessel shall normally be partially filled with water and the bladder filled with compressed air. The vessel will be located outdoors at freezing conditions.

C. Piping, pipe supports, valves, and accessories that are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall coordinate the work between the suppliers of equipment to be used with or connected to the tank to ensure that all required provisions for mounting the accessories are included.

2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Nameplates

1. Each tank shall be provided with a nameplate to identify the service and to identify the tank designation number. The nameplates shall be of white phenolic material with black engraved lettering 3 inches [75 mm] high, and shall be mounted on the tank straight shell. The chemical name and the tank designation number to be engraved on the nameplate.

F. Certification Plate

1. A stainless steel certification plate shall be installed on the side of each storage tank. At least the following data shall be included on the certification plate.

a. Name of tank manufacturer.
b. Maximum allowable working pressure ____ psi at ____ °F
c. Date of manufacture.
d. Mechanical properties of the structure.
   1) Thickness and tensile strength of shell steel.
   2) Thickness and tensile strength of head steel.
e. Name of tank lining material, supplier, and applicator.

G. Governing Standard

1. Except as modified or supplemented herein, design, materials, fabrication, erection, and testing of the pressure vessel shall conform to all sections of ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels.

2. The vessel shall bear the stamp of the National Board of Boiler and Pressure Vessel Inspectors and the manufacturer's number as registered with the National Board.

3. Welding procedures, welders, and welding operators shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings and data covering the tank and accessories shall be submitted in accordance with the Submittals Procedures section including but not limited to the following:

a. Exterior paint color chart
b. General arrangement drawing showing all connection and opening sizes and locations, materials and appurtenances for acceptance
c. Name of manufacturer
d. Dimensions

e. Weight, empty and full of water
f. Material of construction of the bladder
g. Temperature limitations of the bladder
h. Recommended shelf life of the bladder
i. Reaction forces required for structural design of the vessel foundation and anchor bolt plan with anchor bolt sizes, locations and projections. The structural calculations shall be signed by a Professional Civil or Structural Engineer registered in the state of Alabama
j. Full information and details concerning field assembly and installation
k. Storage requirements including spare bladder storage
l. Weld procedure specifications and procedure qualification records
m. Operation and maintenance manuals
n. Pre-charge pressure
o. Functional Test Certification
p. Performance Test Reports

2. The data shall indicate the sizes of all major tank components and full information and details concerning field assembly and installation.

3. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. Operation and maintenance manuals shall include the following:

a. Equipment function, normal operating characteristics, and limiting conditions.
b. Assembly, installation, alignment, adjustment, and checking instructions.
c. Maintenance instructions.
d. Guide to troubleshooting.
e. Parts list and predicted life of parts subject to wear.
f. Outline cross-section, and assembly drawings; and engineering data.
g. Shop Testing: Vessel ASME Form U-1A.
h. Loading and unloading instructions.
i. Storage requirements including spare bladder long term storage and shipping requirements.
j. Manufacturer’s service center address, phone and email address.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.5 SPARE PARTS

A. The following spare parts and extra materials shall be furnished.

Spare Parts	Quantity
Replacement bladder	1

B. Spare parts shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, part nomenclature, part number, address of nearest distributor, and current list price. Spare parts shall be delivered to the Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All tanks shall be designed to operate under the following service conditions:

Installed location.	Outdoor	
Design ambient air temperature range.	20 to 120	° F

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Tanks

1. Each tank shall be designed for the specified design conditions and shall meet the following performance and design requirements as follows:

Tag number	COLW-TNK-1550	
Number of Vessels.	1	
Pressure Vessel Orientation	Vertical	
Maximum Pressure Due to Surge.	90	psi
Vessel Design Pressure	125	psi
Pressure Vessel Volume.	300	gal
Air Volume at 1 Atmosphere.	80	ft^3
Tank Diameter.	3	ft
Connection to Vessel.	10	in
Heater Capacity.	500	W
Heater Supply Voltage/Phase.	120/1	v/ph
Maintained Tank Temperature.	40	°F

2. The vessel shall be steel, electrically welded, vertical cylindrical, with legged torispherical dished head of quality steel of 55,000 psi minimum tensile strength.

3. The minimum required tank wall thickness shall be determined by the tank manufacturer. An additional 1/8 inch corrosion allowance shall be added to the minimum required tank wall thickness.

4. The vessel shall be provided with a flanged inlet/outlet connection. The inlet/outlet connection shall be provided with an acceptable anti-vortex and an anti-extrusion grill.

5. Outlets shall be the sizes indicated and locations shown on the submitted arrangement drawing and as required for all instrumentation and control connection specified or otherwise required.

6. Each tank shall be designed in accordance with the latest edition of Section VIII, Division 1, PART UW of the ASME Boiler and Pressure Vessel Code and shall be stamped. Tanks shall have welds spot checked by radiographic examination. Tanks will be supported on a concrete base.

7. Design criteria for calculating wind, snow, and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

B. Bladders

1. The vessel shall be provided with a Bladder made of Butyl rubber.

2. The bladder shall be safely removable and replaceable.

3. The bladder shall provide an air/water separation preventing dissolution of air into the water at the maximum pressure due to surge.

4. The bladder shall be attached at the top outlet of the vessel such that compressed air is confined inside the bladder and water is confined below the bladder.

5. The bladder shall present a volume and shape, before extension, equal to the internal volume and shape of the surge vessel minus a slight gap.

C. Equipment Bases

1. Unless otherwise indicated or specified, all equipment will be installed on concrete bases at least 6 inches high. The tanks will be anchored to the concrete base with suitable anchor bolts.

D. Anchor Bolts

1. Anchorage design requirements for products specified herein shall be as indicated in the Anchorage in Concrete and Masonry section.

2.3 ACCEPTABLE MANUFACTURERS

A. Manufacturers shall be subject to acceptance by Engineer.

2.4 MATERIALS

Shell and plate	ASTM A36 or ASTM A285, Grade C or ASTM A516, Grade 70.
Nozzle and piping	ASTM A53, Grade A or B, seamless.
Flanges	ASTM A105 raised face. Diameter and drilling to comply with ANSI/ASME B16.5 and class to match vessel pressure rating..
Structural shapes	ASTM A36.
Bolts and nuts	Commercial quality carbon steel square head bolts and heavy cold press hex nuts.
Gaskets	1/16 inch [1.5 mm] thick “Teflon”.
Electrodes	ASME approved, of same composition as the base metal.
Bladder	Heavy- duty butyl bladder.
Finish	Ameron “Amercoat 385 Epoxy,” Carboline “Carboguard 890,” or Tnemec “Series 69, Hi-Build Epoxoline II.”

2.5 CONSTRUCTION

A. The vessel manufacturer shall determine the vessel wall, supports, and dished head wall thicknesses. The bladder vessel shall be designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, for Unfired Pressure Vessels.

B. Welding

1. Each tank and appurtenances shall be fabricated from a minimum number of pieces, and vertical shell seams shall be staggered. Welding seams shall be located to clear all nozzle openings. All flange faces shall be true to the center line of the nozzles, and bolt holes shall straddle center lines unless noted elsewhere. All welding shall be done by the electric arc process. All welding shall be full and continuous, of uniform size and free from slag, porosity, undercuts, and other defects. All welds shall be fully penetrated. The maintenance access flange shall be machined smooth for a gasket surface after welding.

2. The entire interior of each tank shall present a smooth surface free of marked depressions, offsets, abrupt edges, or other protrusions. All welds shall be ground smooth.

3. Flame cut edges, including edges of handholes in vessel skirts, shall be ground smooth.

4. Vessel components shall be carefully fitted to form joints which are free of voids. Voids at joints filled with weld metal will not be acceptable.

5. Maximum allowable working pressure (MAWP) shall be limited by the head, shell, and transitions. MAWP shall not be limited by other minor components such as nozzles or reinforcement pads.

C. Edge Grinding

1. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

D. Surface Preparation

1. All steel surfaces shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

E. Shop Painting

1. All steel surfaces shall be protected by suitable coatings applied in the shop. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. The exterior surfaces of each tank shall be shop primed and finish painted.

2. Exterior Surfaces

a. The exterior surfaces of each tank shall be shop painted with a suitable universal primer. The primer shall be not less than 4 mils dry film thickness (DFT). Field coating shall be as specified in the Protective Coatings section.

2.6 ACCESSORIES

A. Special Tools and Accessories

1. Accessories shall be provided on the bladder vessel as indicated on the piping and instrumentation drawings. The general arrangement of the vessel, including the locations of piping, access flange, bladder, accessories, and other appurtenances, shall be as indicated on the submitted arrangement drawing by the Engineer and specified herein.

2. The number, locations, sizes, and types of piping connections specified herein or indicated on the P&ID are approximate and are subject to change later by the Engineer. Submit a general arrangement drawing for acceptance by the Engineer.

3. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

B. Maintenance Access Flange

1. The maintenance access flange shall have an inside diameter of at least 10 inches and shall be provided on the top of the bladder vessel. The tank manway shall be flanged, fully gasketed, and furnished with a steel blind flange suitable for the bladder vessel design pressure specified herein.

C. Flanged Nozzles

1. Nozzle for connecting piping shall be provided on the bottom of the tank.

2. Tank nozzles shall extend at least 4 inches from outside of face of tank to the face of the flange. Flanged nozzles shall be fabricated of the same material as the tank.

D. Legs

1. The leg supports shall be designed to provide the required clearance and to carry the bladder vessel loads into the foundation, including seismic forces per the Meteorological and Seismic Design Criteria.

E. Connections

1. The ends of butt welding nozzles shall be prepared by machining in accordance with submitted arrangement drawing. The ends of butt welding nozzles shall be internally trimmed by machining where required to match connecting pipe.

2. Unless otherwise indicated on the Drawings, connections shall extend 6 inches from the vessel.

3. Unless otherwise indicated on the Drawings, vessel connections 2 inches and smaller shall be Class 3000 Bonney Sockolets or equal.

4. Unless otherwise indicated on the Drawings, internal and external vessel piping 2 inches and smaller shall be not less than Schedule 80.

F. Gaskets

1. Two sets of gaskets for all manholes, handholes, and blind flanges shall be furnished (temporary and permanent).

2. All manhole covers, handhole covers, and blind flanges shall be fitted with temporary gaskets for use during shipment and erection.

3. The permanent gaskets shall be shipped separately in wooden boxes identified by vessel name and installed prior to commissioning.

4. Gaskets containing asbestos are not acceptable.

G. Pre-charge/Recharge Valve

1. The bladder shall have an isolation valve and a quick connect connection to add gas to the specified pre-charge pressure with compressed oil-less air or nitrogen. The connection size shall be a minimum of 1/2 inch. This quick connection shall be accessible from ground level.

H. Pressure Gauge

1. The unit shall have a 4 1/2” diameter liquid-filled pressure gauge permanently mounted to the vessel. The pressure gauge shall have a phenol case, adjustable pointer, and stainless-steel rotary geared movement.

2. Each gauge shall be accurate to within 0.5 percent of full scale. Gauges shall have a dial size of at least 4 1/2 inches and the units of measurement shall be indicated on the dial face. Pressure gauge ranges shall be such that the normal operating reading will be near the midpoint of the range.

3. The gauge shall have a minimum operating temperature range of -10 deg C to 50 deg C.

4. The range of the pressure gauge shall be 0 to 200 PSI.

5. The gauge shall have a 1/2-inch NPT connection with a shutoff. The connection shall be located at the top of the vessel. Piping to the pressure gauge shall be installed and evenly supported along the side wall of the vessel to a height of 3 feet above the finished surface of the equipment pad.

6. The pressure gauge, shutoff valve and piping shall be heat traced with electric resistance heat tape suitable for outdoor installation and insulated. The gauge shall be Ashcroft without exceptions.

I. Sight Level Gauge

1. The vessel shall be provided with a sight gauge for visual level indication. The gauge shall be clear type or magnetic flag type with a chemical-resistant valve and gauge tube assembly mounted on each vessel.

2. The gauge shall be fabricated of 1-inch diameter clear PVC, polycarbonate, or borosilicate glass each lined with clear PFA Teflon, as specified. An epoxy coated steel shield which does not obstruct the gauge shall be provided the full length of the gauge.

3. A graduation strip shall be mounted adjacent to or integral with the sight level gauge. The strip shall run the full length of the level.

4. The gauge tube assembly shall be Jogler, Inc. "Model ULSS"; Pureflex, Inc. "Model Puresite"; or equal.

5. The vessel manufacturer shall provide confirmation that the sight level gauge is included in the pressure testing of each vessel and that the gauge can withstand the test pressures of each vessel.

6. The top connection for the sight gauge shall be 6-inches below the top of the tank. The bottom connection for the sight gauge shall be 6-inches above the bottom of the tank.

J. Safety Valves

1. Safety valves for air service shall be ASME labeled and shall have carbon steel bodies with stainless steel seats and discs, packed lifting levers, and integral spring enclosures.

2. A safety relief valve device shall be installed to prevent over pressurization of the vessel.

3. The safety valves and drains shall be heat traced with electric resistance heat tape suitable for outdoor installation and insulated.

4. The safety valves shall be as manufactured by Consolidated or Crosby.

K. Vessel Blowoff Valve

1. A globe type blowoff with bronze body and brass stem shall be provided on the surge vessel and shall be located on the precharge/recharge line on a separate tee.

L. Vessel Drain Valve

1. A ball valve drain valve shall be located on the bottom of the pressure vessel. This ball valve shall meet the requirements specified herein.

M. Bottom Connecting Line Valve

1. A ball valve shall be located on the bottom connecting line to the pressure vessel. This ball valve shall meet the requirements specified herein.

N. Tank Insulation

1. The entire exterior area of the sides and top of tanks shall be provided with 2 plies of 1 inch thick polyurethane foam-type insulation having a thermal resistivity of not less than R14. Fiberglass insulation shall not be acceptable. The tanks shall have an aluminum outer protective shell for protection of the insulation.

2. Insulation shall be applied with interruptions for access to manholes, flanges, and other openings without disturbing the insulation. Boxouts with beveled and sealed edges shall be provided around code stamping symbols and nameplates.

O. Tank Heater

1. Hydropneumatic Bladder Tank shall be electrically heated with exterior mounted panel type or strip type heating elements. Immersion heaters will not be acceptable. The tank heater shall be supplied complete with heater, controller, integral heater thermostats, and point level sensing device (if electric point level measurement is not already provided). The heating elements shall be mounted on the side of the tank near the bottom. The heating elements shall be sized to maintain the entire tank contents at a temperature

specified herein, in an outdoor environment. The minimum outdoor ambient temperature shall be as specified herein. Insulation shall be as indicated in this specification section.

2. The tank heater shall consist of one or more heating elements and a maximum of one. Heat elements shall be fastened to the tank with manufacturer-approved adhesive or stainless steel straps and fasteners. Each heating element shall be rated for power supply indicated herein and shall be powered from a controller. Each heating controller shall receive power from a dedicated circuit and be rated up to at least 20 amperes. Heating elements shall not have a power density rating exceeding 0.7 watts/square inch.

3. Each heating element shall be energized with a switch and a temperature sensing device. The temperature sensing device shall be mounted on the tank and under the insulation. When the temperature sensing device detects that the tank contents is below a lower set point temperature, the switch shall change state and energize the respective heating element. When the temperature sensing device detects a temperature above a higher set point temperature, the switch shall de-energize the heating element.

4. The tank heating system shall be furnished with NEMA 4X rated control enclosures and all electrical terminations with regard to incoming power supply and connections to the heating elements and sensing devices. The enclosure shall be mounted adjacent to the tank or on the tank as recommended by the equipment supplier. All required cable between the enclosure and heating elements and temperature sensing devices shall be provided by the heating system supplier.

5. Heating systems shall be designed and provided by a heating system supplier experienced in heating FRP tanks. Heat elements shall be as provided by Chromolox, Calorique, or HTD Heat Tracing systems, or equal.

P. Ball Valves

1. Manually operated two position (open-close) ball valves shall be as specified herein.

Rating	500 psi nonshock cold WOG MSS SP-110
Code	In-line, two piece, end entry, full port
Type	ASTM B584–C84400 bronze
Body/Bonnet	Reinforced Teflon
Trim	Brass, or chrome plated brass
Seat	Brass or bronze
Ball	Reinforced Teflon
Stem	Teflon or Viton
Thrust Washer	Threaded End
Stem Seal	-20 to 400°F
End Connection	Lever
Temp. Limitations	Conbraco Industries "Apollo 77-100
Valve Operator	Series"; Powell "Fig 4210T"
Manufacturers	

Q. Shop Test

1. Submissions shall include Form U-1A “Manufacturers’ Data Report for Unfired Pressure Vessels” prepared by the vessel manufacturer to certify that the vessel was built in accordance with ASME Code Rules for the Construction of Unfired Pressure Vessels and inspected by a certified inspector. Copies of the form shall be included in the Operation and Maintenance Manual.

R. Hydrostatic Pressure Test

1. The bladder vessel shall be hydrostatically pressure tested as required by the ASME Boiler and Pressure Vessel Code at the vessel manufacturer’s shop. At a minimum testing shall be to 1.3 times working pressure for a minimum of 2 hours and checked for leaks.

2. During testing, connections shall be plugged outside the vessel. Any leaks shall be repaired, and the bladder vessel shall be retested.

PART 3 - EXECUTION

3.1 FABRICATION

A. The surge control system shall be completely shop fabricated; no fabrication will be allowed in the field. Fieldwork shall be limited to assembly of accessories, making piping and wiring interconnections, and testing and startup.

3.2 FIELD HYDROSTATIC PRESSURE TEST

A. The bladder vessel shall undergo a field hydrostatic pressure test prior to Commissioning. The field hydrostatic pressure test shall be performed by Contractor.

B. Field hydrostatic pressure test shall meet the same requirements as the hydrostatic pressure test specified herein.

3.3 WARRANTY

A. The installed vessel shall be warranted against defects in workmanship and material for a period of two years from delivery date.

B. If the installed equipment is defective or does not meet the specified performance criteria, the installed equipment must be removed and replaced with equipment that will meet the specified performance criteria. Costs associated with equipment replacement required as a result of a defect or failure will not be allowed as a reimbursable project cost.

C. Manufacturer shall provide certificates for additional replacement bladder to be redeemed upon replacement so one spare bladder is maintained on site at all times. The supplier shall maintain one spare replacement bladder on site at all times for the two year warranty period at no additional cost to the client.

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the bladder vessel manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. When the system is initially put in service a water level measurement and an air pressure measurement at static conditions shall be taken and used as a benchmark for future wet recharge of the system

3. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and pre-loaded; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily. The report shall include the benchmark measurements for water level and air pressure at static conditions.

4. All costs for these services shall be included in the contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.5 TRAINING

1. The bladder vessel manufacturer's representative shall provide a minimum of 4 hours, travel excluded, on site training for Owner’s staff in proper operation and maintenance of the equipment.

End of Section

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Section 46 33 00 - LIQUID CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers liquid chemical feed equipment and accessories. Principal items to be furnished and installed shall include the following:

1. Sodium Bisulfite Chemical Feed System.

    a. One Quick Connect Adapter
    b. Two Calibration Columns
    c. Two Metering Pumps
    d. One Metering Pump Control Panel
    e. One Metering Pump Skid
    f. One Diffuser

2. Sodium Hypochlorite Chemical Feed System.

    a. One Quick Connect Adapters
    b. Two Calibration Columns
    c. Two Metering Pumps
    d. One Metering Pump Control Panel
    e. One Metering Pump Skid

3. Sulfuric Acid Chemical Feed System

    a. Two Quick Connect Adapters
    b. Two Quick Connect Couplers
    c. Two Tote Scales
    d. Two Calibration Columns
    e. Two Metering Pumps
    f. One Metering Pump Control Panel
    g. One Metering Pump Skid
    h. One Dilution Panel

B. The following items of work and equipment are covered under other sections:

1. Piping and valves between items of equipment.

2. Water supply and electric power supply to the equipment.

3. Drain and vent piping.

1.2 CHEMICAL FEED SYSTEM INTEGRATOR.

A. General

1. The chemical feed systems shall be designed, coordinated, and supplied by a competent Chemical Feed System Integrator.

2. The Chemical Feed System Integrator shall be regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects.

3. The Chemical Feed System Integrator shall be responsible for ensuring that a complete functioning system is supplied for each Chemical Feed System.

4. The Chemical Feed System Integrator shall be responsible for coordinating all equipment, piping, and valves, and appurtenances for each Chemical Feed System.

B. Chemical Feed System Integrator Qualifications.

1. The Chemical Feed System Integrator shall meet all of the following requirements and within 30 days after the Notice of Award, the Contractor shall submit proof of the following qualifications for the intended Chemical Feed System Integrator:

a. The Chemical Feed System Integrator has successfully provided similar work for at least 5 years.
b. The names of at least three references who are users of similar systems designed, assembled, and furnished by the Chemical Feed System Integrator.
c. The Chemical Feed System Integrator has the required financial capability.
d. The names of manufacturers whose products will be supplied.
e. The Chemical Feed System Integrator maintains a qualified technical staff and design office.
f. The Chemical Feed System Integrator has the physical plant and fabricating personnel to complete the work specified.
g. The Chemical Feed System Integrator has and will maintain competent service personnel to service the equipment furnished.

1.3 GENERAL.

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

B. Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation, all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

C. Coordination.

1. The Chemical Feed System Integrator shall verify that each system component is compatible and consistent with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning system have been provided and installed.

2. Devices and appurtenances necessary for a properly functioning system shall be constructed of materials consistent with the piping materials unless otherwise indicated.

3. The Chemical Feed System Integrator shall assume responsibility for ensuring that Minimum Suction Head and NPSH available is adequate for the supplied pumps.

4. Similar components of different chemical feed systems shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

5. Review of drawings submitted prior to the final determination and coordination of related equipment to be provided will not relieve the Contractor from responsibility for supplying systems in full compliance with the specific requirements of the related equipment.

D. General Equipment Stipulations.

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. Piping on skids shall be constructed consistent with the piping and valve specifications.

E. Governing Standards.

1. All electrical equipment shall conform to applicable standards of the National Electrical Manufacturers Association and the National Electrical Code.

F. Power Supply.

1. Unless otherwise specified, the power supply will be 480 volts, 60 Hz, three phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished. Both power and control

equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

G. Metal Thicknesses.

1. Metal thicknesses and gauges specified herein are the minimum required. Gauges refer to US Standard gauge.

H. Nameplates.

1. A nameplate shall be provided and mounted on or adjacent to each piece of chemical feed equipment to identify its function and identifying tag number corresponding to those indicated on the drawings.

2. Nameplates shall be approximately 1 by 3 inches, made from black on white phenolic material.

3. Letters shall be engraved to the white interior and shall be at least 3/16-inch high.

I. Spare Parts.

1. A list of recommended spare parts with pricing shall be furnished during the submittal phase.

1.4 SUBMITTALS.

A. General

1. Submittals for chemical feed systems shall have the following organization and information as a minimum.

B. Submittal Organization.

1. The submittal shall be split up into different sections with a separate section for each chemical feed system. Each system section shall be supplied with the following information.

a. Chemical Feed System Integrator Name, Contact Name, Phone Number, Address, and email address.
b. Chemical Feed System Integrator Contact Name Qualifications and Experience.
c. Bill of Materials.
d. System piping and instrumentation diagram (P&ID) with legend.
e. Equipment and piping layout starting from bulk storage tank pump suction nozzle to discharge of anti-siphon loop.
f. Tote scale selection.

g. Quick connect adapters selection.
h. Quick connect couplers selection.
i. Metering pump selections.
j. Metering pump appurtenances selections including calibration column.
k. Control Panel layout and wiring diagrams.
l. Diffuser selection.
m. Control narrative.
n. Recommended spare parts.

C. Drawings and Data.

1. Complete fabrication, assembly, installation and equipment and piping layout drawings, piping and instrumentation diagrams, and wiring diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Section.

D. Calibration Graphs.

1. The Chemical Feed System Integrator shall prepare a calibration graph from field tests for each chemical feed pump. Each graph shall include a family of curves of pump speed/stroke length versus gallons per hour at 25, 50, 75 and 100 percent speed and 10, 25, 50, 75, and 100 percent stroke length. Each graph shall be furnished on hard paper and sealed in clear plastic.

E. Control Narrative.

1. A narrative description of the proposed metering pump controls, including all control modes, manual and automatic operations, electrical interlocks, alarms, and interfaces to the Plant Control System shall be submitted.

F. Operation and Maintenance Data and Manuals.

1. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with the submittals section. Equipment designations used shall correspond to those indicated on the drawings.

2. Operation and maintenance manuals shall include the following:

a. Equipment function, normal operating characteristics, and limiting conditions.
b. Assembly, installation, alignment, adjustment, and checking instructions.
c. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.
d. Lubrication and maintenance instructions.
e. Guide to troubleshooting.

f. Parts lists and predicted life of parts subject to wear.
g. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.
h. Test data and performance curves, where applicable.
i. A listing of all filter locations, type, size, and quantity associated with each piece of equipment.

3. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2.1 CHEMICAL FEED SYSTEM INTEGRATOR.

A. The chemical feed system shall be coordinated and supplied by a qualified Chemical Feed System Integrator who is regularly engaged in the business of designing and assembling liquid chemical feed systems for water treatment or wastewater treatment plant projects.

2.2 GENERAL CONSTRUCTION.

A. Chemical feed equipment shall be of substantial construction with all parts designed for long life under working conditions including corrosive atmospheres and intermittent or continuous operation.

B. All wearing parts and items requiring adjustment shall be readily accessible.

C. Each unit shall be completely enclosed and dusttight when in operation.

D. All parts which are exposed to corrosive conditions shall be made from corrosion-resistant materials or covered with suitable protective coatings.

2.3 SODIUM BISULFITE CHEMCAL FEED SYSTEM.

A. One assembly of feeding equipment shall be furnished and installed to dispense sodium bisulfite to the following feed points:

1. Chlorine Contact Basin Effluent

B. Chemical Solution Properties

1. 38% sodium bisulfite solution with a specific gravity of 1.34.

C. Quick Connect Adapters

1. Quick Connect Adapter Requirements:

a. Location: Truck unloading station
b. Quantity: One
c. Materials: Polypropylene

D. Calibration Columns

1. Calibration Column Requirements:

a. Associated Pump Tag Number(s): NHS-PDM-4210, NHS-PDM-4220
b. Quantity: 2
c. Diameter, inch: 2
d. Flow Fitting Size, inch: 0.5
e. Range, gallons: 0 – 0.2
f. Graduation Increments, gallons: 0.01

E. Metering Pumps

1. Metering Pump Requirements:

a. Feed Point(s): Chlorine Contact Basin Effluent
b. Pump Quantity: 2 (1 duty, 1 standby)
c. Pump Type: Mechanically-actuated Diaphragm
d. Tag Number(s): NHS-PDM-4210, NHS-PDM-4220
e. Capacity Control Range, Percent: 0 to 100
f. Metering Range, gph: 0.55 - 10
g. Minimum Drive Motor, hp: 0.5
h. Maximum Stroke Rate at Rated Conditions, spm: 100
i. Accuracy, percent of scale over metering range: 2%
j. Minimum Suction Head Required, psia: 9.5
k. Nominal Discharge Pressure, psi: 55

F. Metering Pump Skids

1. Metering Pump Skid Requirements:

a. Metering Pump Skid Quantity: One
b. Metering Pump Tags: NHS-PDM-4210, NHS-PDM-4220
c. Metering Pump per Skid: Two
d. Maximum Skid Footprint: 66 inches x 36 inches
e. Skid frame materials: PP/PE
f. Skid piping materials: PVC
g. Skid Valve Type: ball

h. Installation Location: Sodium Bisulfite Containment Area

G. Diffusers

1. Diffuser Requirements:

a. Feed Point: Chlorine Contact Basin
b. Diffuser Quantity: 1
c. Diffuser Type: Channel type

2.4 SODIUM HYPOCHLORITE CHEMICAL FEED SYSTEM.

A. One assembly of feeding equipment shall be furnished and installed to dispense sodium bisulfite to the following feed points:

1. Chlorine Contact Basin

B. Chemical Solution Properties

1. 12.5% sodium hypochlorite solution with a specific gravity of 1.175.

C. Quick Connect Adapters

1. Quick Connect Adapter Requirements:

a. Location: Truck unloading station
b. Quantity: One
c. Materials: Polypropylene

D. Calibration Columns

1. Calibration Column Requirements:

a. Associated Pump Tag Number(s): NOCL-PDM-4110, NOCL-PDM-4120
b. Quantity: 2
c. Diameter, inch: 6
d. Flow Fitting Size, inch: 1
e. Range, gallons: 0 – 1.35
f. Graduation Increments, gallons: 0.05

E. Metering Pumps

1. Metering Pump Requirements:

a. Feed Point(s): Chlorine Contact Basin
b. Pump Quantity: 2 (1 duty, 1 standby)

c. Pump Type: Mechanically-actuated Diaphragm
d. Tag Number(s): NOCL-PDM-4110, NOCL-PDM-4120
e. Capacity Control Range, Percent: 0 to 100
f. Metering Range, gph: 4.6 - 80
g. Minimum Drive Motor, hp: 1
h. Maximum Stroke Rate at Rated Conditions, spm: 120
i. Accuracy, percent of scale over metering range: 2%
j. Minimum Suction Head Required, psia: 9.5
k. Nominal Discharge Pressure, psi: 55

F. Metering Pump Skids

1. Metering Pump Skid Requirements:

a. Metering Pump Skid Quantity: One
b. Metering Pump Tags: NOCL-PDM-4110, NOCL-PDM-4120
c. Metering Pump per Skid: Two
d. Maximum Skid Footprint: 66 inches x 36 inches
e. Skid frame materials: PP/PE
f. Skid piping materials: CPVC
g. Skid Valve Type: diaphragm
h. Installation Location: sodium hypochlorite containment area

2.5 SULFURIC ACID CHEMICAL FEED SYSTEM.

A. One assembly of feeding equipment shall be furnished and installed to dispense sulfuric acid to the following feed points:

1. Upstream of the chlorine contact basin

B. Chemical Solution Properties

1. 93% sulfuric acid solution with a specific gravity of 1.84.

C. Quick Connect Adapters

1. Quick Connect Adapter Requirements:

a. Location: Storage tote flexible connection
b. Quantity: Two
c. Materials: Alloy 20

D. Quick Connect Couplers

1. Quick Connect Coupler Requirements:

a. Location: Storage tote flexible connection
b. Quantity: Two
c. Materials: Alloy 20

E. Calibration Columns

1. Calibration Column Requirements:

a. Associated Pump Tag Number(s): HSO4-PDM-4010, HS04-PDM-4020
b. Quantity: 2
c. Diameter, inch: 1
d. Flow Fitting Size, inch: 0.5
e. Range, gallons: 0 – 0.05
f. Graduation Increments, gallons: 0.005

F. Metering Pumps

1. Metering Pump Requirements:

a. Feed Point(s): Upstream of the Chlorine Contact Basin
b. Pump Quantity: 2 (1 duty, 1 standby)
c. Pump Type: Mechanically-actuated Diaphragm
d. Tag Number(s): HSO4-PDM-4010, HS04-PDM-4020
e. Capacity Control Range, Percent: 0 to 100
f. Metering Range, gph: 0.16 – 2.60
g. Minimum Drive Motor, hp: 0.5
h. Maximum Stroke Rate at Rated Conditions, spm: 100
i. Accuracy, percent of scale over metering range: 2%
j. Minimum Suction Head Required, psia: 9.5
k. Nominal Discharge Pressure, psi: 55

G. Metering Pump Skids

1. Metering Pump Skid Requirements:

a. Metering Pump Skid Quantity: One
b. Metering Pump Tags: HSO4-PDM-4010, HS04-PDM-4020
c. Metering Pump per Skid: Two
d. Maximum Skid Footprint: 66 inches x 36 inches
e. Skid frame materials: PP/PE
f. Skid piping materials: alloy 20
g. Skid Valve Type: ball
h. Installation Location: sulfuric acid containment area

2.6 QUICK CONNECT ADAPTERS

A. Quick connect adapter*s* shall be provided as shown on the drawings and as specified in the individual chemical system paragraphs of this section.

B. The material of construction shall be compatible with the chemical and approved by the Engineer. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D.

C. The quick connect fitting shall be the adapter type (grooved fitting) with a locking dust cap.

D. The adapter shall be constructed of material suitable for the chemical service with female NPT threads for connecting to the fill piping.

E. The adapter*s* shall be the same size as the associated fill line as indicated on the drawings.

F. The quick connect adapters shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, or equal.

2.7 QUICK CONNECT COUPLERS

A. Quick connect couplers shall be furnished and installed on the hose connections for the chemical delivery tote as indicated on the drawings.

B. The material of construction shall be compatible with the chemical and approved by the Engineer. The quick connect shall be the standard cam and groove type manufactured to specification A-A-59326D.

C. The quick connect fitting shall be the coupler type with cam arms and hose shank or female NPT threads for connecting to hose or piping as indicated on the drawings.

D. The coupler shall be the same size as the hoses or piping as indicated on the drawings.

E. The quick connect coupler shall be as manufactured by OPW Engineered Systems, PT Coupling Company, Inc, without exception.

2.8 CHEMICAL TOTE CONTAINMENT AND LEVEL MEASUREMENT

A. One containment pallet and scale shall be provided for each tote. This unit may be a single assemblage or individual pieces as acceptable to the Engineer.

B. Tote Containment

1. Each containment pallet shall have a capacity of 400 gallons.

2. Each containment pallet shall include a platform that can support totes measuring 38 to 50 inches in width.

3. The maximum load capacity shall be 10,000 pounds and the pallet shall be constructed of polyethylene or other chemically resistant material.

4. Pallets shall be Interstate Products, Inc. “1680 IBC Spill Unit” or equal.

C. Tote Scale

1. One electronic load cell scale of the digital type shall be furnished and installed for each chemical tote as shown on the Drawings.

2. The scale shall have a total weighing capacity of a minimum of 8,500 lbs and shall be designed for floor surface mounting.

3. The scale shall include a digital electronic indicator with capability of transmitting a loop powered 4-20 mA dc signal to the plant control system. The indicator shall have the capability of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicator programming and tare weight entry. The indicator shall be programmable over the entire range of the scale in 1-pound increments.

4. The scale shall be Eagle Microsystems "LP4300 Platform Scale" with "EI 1000 Indicator" or Force Flow Equipment "Model 72-DR100LPHA4 Scale" with "Wizard 4000 Indicator", Scaletron Industries Ltd. “Model 4042-63”, or equal.

2.9 CALIBRATION COLUMNS

A. Unless otherwise shown on the drawings, one transparent plastic calibrating column shall be furnished and installed on the pump suction piping, of each chemical feed metering pump, as indicated on the drawings.

B. The column shall be a clear PVC or other chemically-resistant, rigid, transparent material having a vented top cap and screwed flow fitting as indicated in the individual chemical system paragraphs of this section.

C. Capacities and graduation units for each calibration column shall be as covered in the individual chemical system paragraphs of this section.

D. The bottom of the calibration column shall be located at or below the bottom of elevation of the storage/day tank metering pump suction nozzle.

E. The columns shall be Valcom, Inc., "Model 85000", or equal, and shall be mounted on steel legs.

2.10 METERING PUMPS – MOTOR DRIVEN DIAPHRAGM TYPE

A. Performance

1. Specific pump quantities and performance requirements are covered in the individual chemical system paragraphs of this section.

B. Pump Requirements

1. Each pump shall be of the positive displacement type using a mechanically actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housings.

2. Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

3. Inlet and outlet check valves shall be of the single valve type, with valve housing which are removable without disassembly of the pipe fittings.

4. For sulfuric acid service, material of construction of the pump head, check valves, and pump appurtenances shall be alloy 20, or other chemically resistant material as acceptable to the Engineer.

5. For all other chemical services, materials of construction shall be selected for resistance to the pumped solution, as acceptable to the Engineer.

6. The rate of metering shall be changed by manually or automatically varying the stroking speed and the stroke length. Minimum flow rate shall be achieved at a stroking length not less than 10 percent (40 percent for NaOCl) and a stroking speed not less than 20 spm (10 spm for NaOCl).

7. Each pump liquid end shall be equipped with a manual mechanical stroke length adjustment knob to provide capacity adjustment without the use of tools and while the pump is running. All moving parts shall be totally enclosed and self-lubricating.

8. Each pump liquid end shall be equipped with an automatic electronic stroke length controller set to operate from a remote signal. The input signal shall be 4-20 mA dc and shall be ungrounded type with an input resistance of not more than 250 ohms.

9. Motor horsepower for each pump shall be based on the individual chemical system performance requirements and on the discharge back pressure required by the furnished pump. Motor shall not be less than the indicated horsepower. Power to the motor shall be provided by an adjustable frequency drive (AFD) controlled rate controller as specified herein**.** Power and control wiring from the controller to the motor shall be provided by the pump supplier.

    a. Motor shall be supplied with a tachometer to close the loop with the variable speed drive.

10. Each pump motor shall be equipped with an AFD. AFDs shall be as specified in the Adjustable Frequency Drive section.

11. Each pump shall be mounted on a corrosion-resistant coated structural steel or cast-iron base to be set on a concrete support as indicated on the drawings and shall include a self-lubricating speed reducer.

12. Each pump shall be furnished with the following accessories. All metering pump suction and discharge appurtenances described below and branch piping to these appurtenances shall be the same sizes as the suction and discharge piping indicated on the P&ID.

    a. One strainer installed in the inlet piping.
        1) For sodium bisulfite service the strainer shall be fabricated of transparent PVC bodied Y-pattern with 8-mesh screen and EPDM O-ring seals.
        2) For sodium hypochlorite service the strainer shall be fabricated of CPVC bodied Y-pattern with 8-mesh screen and Viton O-ring seals.
        3) For sulfuric acid service the strainer shall be fabricated of alloy 20 bodied Y-pattern with 8-mesh screen and Viton O-ring seals.

    b. One properly sized diaphragm type pulsation dampener in each pump suction piping arrangement where shown on the P&IDs. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

    c. One pressure gauge and high-pressure switch with isolating diaphragm installed in the discharge piping. The pressure gauge shall be indicating dial type with adjustable pointer and acrylic plastic or shatterproof glass window. The dial shall be 4-1/2 inches in diameter, with white background and black markings. Pointer travel shall be approximately 270 degrees. The unit of measurement shall be pounds per square inch and shall be indicated on the dial face. The gauge shall be selected so that gauge readings will be mid-scale under normal operating conditions.

1) The high-pressure switch shall be of the diaphragm type, shall have a weatherproof housing, shall have a trip point reliability better than 1 percent of actual pressure, and shall at minimum be SPDT rated at 10 amp at 120 VAC. The isolating diaphragm shall protect the pressure instruments from the chemical solution.

d. One external pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacturer. The pressure relief valve shall be fabricated of materials matching the specified pipe materials for each chemical service.

e. One properly sized backpressure valve as recommended by the manufacturer. The backpressure valve shall be fabricated of materials matching the specified pipe materials for each chemical service.

f. One properly sized diaphragm type pulsation dampener in each pump discharge piping arrangement. Each pulsation dampener shall be fabricated of materials resistant to the pumped solution and shall include an air charging valve and air gauge. The pulsation dampener shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

13. All wiring shall be furnished complete and ready for connection of an external power circuit.

14. Metering pumps shall be as manufactured by Milton Roy "MacRoy", Pulsafeeder "Greenline", Prominent "Sigma", or equal.

C. Diaphragm Metering Pump Control Panels

1. For variable speed diaphragm metering pumps, the pump supplier shall provide a local control panel for each skid. The control panel shall house the AFD drive and control components required for operation of both metering pumps as specified herein.

2. The control panel shall be a fiberglass or 316 SS NEMA Type 4X enclosure mounted on the pump skid complete with wiring to the pump motors and other skid mounted devices.

3. All wiring terminals shall be furnished complete and ready for connection to the external power supply and the remote pump controls. The control panel shall be provided with an engraved nameplate indicating the controlled units, and nameplates for all major components contained on the panel face and within the control panel.

4. Control panels for variable speed diaphragm metering pumps shall have an "On-Off-Remote" switch and local speed adjustment on the panel front. When "On" is selected, the pump shall run, and speed shall be adjusted using the local controls. When "Remote" is selected, start/stop control shall be by a normally

open contact input to the panel, and speed control shall be by a 4-20 mA input. Indicating lights shall be provided on the panel front for "Running", "Stopped", and "Drive Failure". These indicating lights shall be red, green, and amber respectively. Where a high discharge pressure switch is indicated on the drawings or specified to be provided for the pump, the pump shall shut down on high discharge pressure, and an amber "High Discharge Pressure" indicating light on the panel front shall illuminate. Where a diaphragm leak detection system is indicated on the drawings or specified to be provided for the pump, the pump shall shut down on diaphragm leakage and an amber "Diaphragm Failure" indicating light on the panel front shall illuminate. LCD or similar type display functions are acceptable alternatives to indicating lights.

5. Outputs shall be provided from panels for variable speed diaphragm metering pumps as follows:

   a. In Remote (Normally Open (NO) dry contact)
   b. Running (NO dry contact)
   c. Common Fail (NO dry contact)
   d. Hi Pressure (NO dry contact)
   e. Speed Indication (4-20 mA)
   f. Stroke Length (4-20 mA)

6. The signal controlling the Fail contact shall be generated by the SCR drive. Where high discharge pressure and/or diaphragm leakage is monitored, the Fail contact shall include these conditions. Manual reset of the failure condition shall be required at the control panel.

7. The electronic stroke length controller shall be provided with a "Local-Remote" switch. When "Remote" is selected, stroke length adjustment shall be by a 4-20 mA input signal. When "Local" is selected, stroke length control by the 4-20 mA input signal shall be disabled and stroke length shall be adjusted manually. A 4-20 mA output signal proportional to stroke length shall also be provided. The controller and related devices shall have NEMA 4X enclosures.

2.11 METERING PUMP SKIDS

A. Where indicated on the drawings or specified in the individual chemical system paragraphs of this section, metering pump systems shall be factory assembled skid mounted units.

B. The skid shall include the indicated metering pump(s) on the skid, pipe appurtenances, appropriate valves and piping, calibration columns, and a control panel.

C. The piping requirements, valving, and appurtenances shall be as shown on the piping and instrument diagrams.

D. Each skid shall have a dedicated control panel, and all power and control wiring within the skid shall be provided by the Chemical Feed System Integrator such that the skid requires connection of a single primary 480V, 3phase 20A power circuit.

1. Control panel shall be provided with a main circuit breaker and shall have a minimum 10,000AIC rating. AIC rating shall be increased as required to meet short circuit current calculation from coordination and arc flash study required by Electrical section.

2. Panel shall be UL listed.

E. Skids shall be of substantial construction, shall be constructed of a material resistant to the pumped solution, and shall have an open construction such that there is unobstructed access to the controls, pump head, and pump check valves.

F. Valves and appurtenances shall be within easy reach from the skid edge.

G. Fluid velocities in plastic pipe shall not exceed 5 feet per second.

H. Valves shall be type shall be as indicated on the P&IDs and as specified in the respective valve section. Valves shall be labeled with valve numbers shown on the P&IDs. Valves shall conform to the respective valve type specification sections.

2.12 DILUTION PANEL

A. One wall mounted dilution panel shall be provided for dilution of 93 percent pumped sulfuric acid to 5 percent solution prior to each delivery point.

B. The dilution pump panel shall include a plant service water connection sized to supply dilution water at a rate of 2 gpm and a minimum pressure of 45 psig.

C. One acid mixing assembly for the system shall be provided. Refer to the Drawings for details.

D. Water control components and piping within the sulfuric acid dilution water panel for each feed point shall include an isolation valve, pressure reducing valve, pressure gauge, rotameter, low flow switch, dilution water check valve, manual throttling globe valve, acid injection line check valves, acid mixing assembly, Neptune CS-50-C20 injection quill, temperature gauge, and high temperature switch as indicated on the P&IDs.

1. Conditions of low water flow or high temperature downstream of the acid mixing tee shall shut off the acid metering pumps.

E. Each Panel shall be rigidly supported for wall mounting in the location indicated on the Drawings.

1. Each panel shall be constructed of 1/2 inch thick PVC or polyethylene boards suitably reinforced.

2. Each panel shall be a frame assembly that permits removal of components mounted on the panel.

3. The panel nameplates, and all components, shall be mounted on the panel by the equipment supplier for field installation by Contractor.

F. Each panel shall be furnished with the following accessories.

1. Pressure gauges shall be furnished as indicated on the drawings.

   a. The pressure gauge shall be indicating dial type with adjustable point and acrylic plastic or shatterproof glass window.
   b. The dial shall be 4.5 inches in diameter, with white background and black markings.
   c. Pointer travel shall be approximately 270 degrees.
   d. The unit of measurement shall be PSI, and shall be indicated on the dial face.
   e. The gauge shall be selected such that gauge readings will be mid-scale under normal operating conditions.
   f. The pressure gauge shall be Ashcroft 1279, or equal.

2. The rotameter and flow control valves shall provide for manual throttling of the dilution water flow rate to the acid mixing assembly.

   a. The rotameter shall be of the float and tampered tube design with local readout.
   b. Rotameter internals shall be of stainless steel construction.
   c. The rotamer shall be capable of reading 1.25 times the flow for the feedpoint as indicated in the above text and shall be rated for the above water pressure requirements at a minimum.
   d. The rotameter shall be King Instrument 7910, or equal.

3. A low flow switch shall be provided with each rotameter to alarm low flow and to stop the acid metering pumps from running when the dilution water supply to the feedpoint is low.

4. One temperature gauge and high temperature switch shall be furnished on the dilution acid piping as indicated on the Drawings.

   a. Temperature gauges and switches shall be in accordance with the Temperature Instruments section and shall be provided with thermowells.
   b. Temperature switch shall be diaphragm actuated type switch.

c. Temperature switch shall be field adjustable type, with trip point repeatability better than 1% of actual.
d. Switch shall have over-range protection to maximum water line pressure.
e. The switch shall have weatherproof housings and be provided with 1/2 inch NPT connections.
f. Unless otherwise indicated, the switch shall have a fixed deadband and shall be auto-reset type.
g. As a minimum the switch shall be SPDT, rated 10 amp at 220 VAC.
h. Thread sealer, suitable for use with the service water, shall be used in the assembly of threaded connections.
i. All connections shall be free of leaks.
j. Components in contact with dilute sulfuric acid shall be carpenter 20 material, or other material, as recommended by the manufacturer for the chemical service and as acceptable to Engineer.
k. High diluted acid temperature shall shut off the sulfuric acid metering pump.

5. Transition fittings shall be provided to connect CPVC piping and components to metallic piping.

a. All plastic-to-metal piping transition fittings are to be Spears Manufacturing Company CPVC Type IV, Cell Classification 23447.
b. All transition fittings shall contain a molded-in-place Threaded Metal insert conforming to ANSI B1.20.1 internal tapered pipe thread dimensions with internal O-ring seal.

6. One acid mixing assembly shall be provided for the mixing of dilution water with 93 percent sulfuric acid as indicated on the Drawings.

a. Each mixing assembly shall be a one-piece tee shaped device of 2 inch, schedule 40 carpenter 20 with flanged ends.
b. The assembly length shall extend at least one foot downstream of the acid inlet and 6 inches upstream of the acid inlet.
c. A removable acid diffuser, Neptune CS-50-C20, shall extend inside the assembly as indicated on the Drawings.
d. Assembly gaskets shall be Viton material.

2.13 SODIUM HYPOCHLORITE PRESSURE RELIEF VALVES

A. Sodium hypochlorite pressure relief valves shall be located anywhere sodium hypochlorite can become trapped in the chemical feed piping and not less than as indicated on the drawings to protect the system from damage due to excess pressure build-up resulting from the decomposition of sodium hypochlorite.

B. Valves shall have adjustable relief pressure setting, with initial relief pressure set at 120 psi.

C. The valve body shall be constructed of CPVC.

D. All wetted materials including seats, seals and diaphragms shall be constructed of CPVC, Viton, or Teflon, as acceptable to Engineer.

E. Each valve shall be supplied with a tamper proof seal, which must be broken in order to change the factory pressure setting.

F. A tag indicating the initial pressure setting shall be provided.

G. Valves shall be Griffco Valve, Inc. "Pressure Relief Valves," Hydroflo Corporation "HydroGarD High Pressure Safety Relief Valves," or Plast-O-Matic “Series RVDT.”

PART 3 - EXECUTION

3.1 SHIPPING.

A. Prior to being shipped, the skids shall be thoroughly dried.

B. Shipping of the skids shall conform to Product Delivery Requirements section such that the skids are not damaged in transit.

3.2 INSTALLATION.

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Drawings, specifications, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer. All items necessary for a complete operating system shall be installed.

B. Equipment Bases.

1. Unless otherwise specified or indicated on the Drawings, each item of chemical feed equipment shall be mounted on a concrete base approximately six inches above the floor. If feeders or other components must be supported at higher elevations above the floor, suitable supplementary bases shall be provided.

C. Installation Check.

1. An experienced, competent, and authorized representative of the Chemical Feed System Integrator shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be

present when equipment is placed in operation in accordance with the Equipment Installation section and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The Chemical Feed System Integrator's representative shall furnish a written report certifying that the equipment has been properly installed; that gas piping has been properly cleaned; is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; and has been operated at full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price for the number of days and round trips to the site as required.

3.3 CLEANING.

A. At the completion of installation and testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.4 TRAINING.

A. The Chemical Feed System Integrator shall provide a qualified representative at the jobsite for one day to train the Owner's personnel in operating and maintaining the equipment.

End of Section

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SECTION 46 51 13 - FLOATING BRUSH AERATORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of floating mechanical type surface aeration equipment.

Equipment designation. Floating Brush Aerator

Number of units. 5

Equipment tag numbers.

Influent Pond	LAG-AFS-2001
Influent Pond	LAG-AFS-2004
Influent Pond	LAG-AFS-2005
Polishing Pond	LAG-AFS-2011
Polishing Pond	LAG-AFS-2012

1.2 GENERAL

A. The floating aerators will be used in aeration lagoons

B. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

C. Each unit shall be furnished complete with all mechanical equipment required for proper operation, including complete drive units, mooring construction indicated on the drawings, and any additional materials or construction required by the manufacturer's design.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Seismic and Wind Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

F. Identification

1. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. The Manufacturer shall provide the Contractor submittals showing full details of all aeration equipment and appurtenances.

2. This submission shall be made as soon as feasible after Contract award or Approved Purchase Order is agreed upon between the Contractor and Manufacturer. The Manufacturer shall provide the Contractor with four (4) copies of the submittal for approval by the Engineer. After submittal approval, the Manufacturer shall receive an approved copy of the submittal for their records. Manufacturing of aeration equipment & systems will begin after the submittals are approved.

3. The information required on the submittals shall include, but not necessarily be limited to the following:

   a. Full and complete specifications covering the equipment and appurtenances to be furnished, including certified aeration design provided by Floating Brush Aeration Design Engineer. The design shall show the mixing and oxygen capabilities of the Floating Brush Aerator.
   b. Detail drawings showing plan and elevation dimensions of the proposed equipment and appurtenances to be furnished.
   c. Assembly, installation, and adjustment instructions.
   d. The location of the floating brush aerator manufacturer.
   e. Full and complete specifications for the complete drive-train system that operates the floating brush aerators.
   f. Provide floating brush aerator assembled weight, and the weights of individual pieces that will be unloaded & installed.
   g. Provide Manufacturing warranty as specified herein.
   h. Floating brush aerator troubleshooting guide.
   i. Electrical requirements, including power and control wiring schematics. Failure to submit the above data as set forth shall be cause for rejection of the submittal and equipment.
   j. Shaft size and material.
   k. Type and ratings of bearings.
   l. Details of flotation support.
   m. Details of mooring support frame.
   n. Details of fixed supports and mooring to fixed supports.
   o. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section
   p. Full and complete specifications covering the proposed equipment
   q. Previous testing reports about aeration efficiency

B. Operation and Maintenance Manuals

1. Upon the Engineer's approval of submittals the manufacture shall provide four (4) copies of the operation and maintenance manuals to the Contractor.

2. The O&M manuals shall include details of all components, installation instructions, start-up procedures, and operation and maintenance procedures. The O&M Manuals shall include all lubrication specifications and lubrication maintenance details. The O&M manuals shall include specific instructions for receiving and handling, assembly, mooring, wiring, installation, repair, service and storage.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Care shall be taken to avoid supporting or lifting the surface aerator in a manner that will place excessive stress on parts or shaft extensions that are not designed to support the weight of unit. The aerator assembly shall be lifted by lifting eyes or slings. The output shaft shall be protected from external forces at all times.

1.5 MANUFACTURER'S EXPERIENCE

A. The aerators shall be a product of a manufacturer experienced in the design and fabrication of equipment of this type. The manufacturer shall provide evidence of having supplied similar equipment which meets or exceeds the performance and design requirements specified herein.

B. The aeration equipment manufacturer shall be approved by the Engineer and Owner.

C. The aeration system supplier shall be experienced in wastewater treatment processes and shall be prepared to demonstrate the effect on the client's process of the aeration systems supplied through documented analysis relating to flow, hydraulic retention time, and biological contact. Certified Oxygen Transfer & Mixing Tests performed by an independent third party shall be made available to the Engineer & Owner. These tests should support the aeration system design, and show the aeration system can provide the oxygen & mixing necessary for proper and effective wastewater treatment.

D. The floating brush aeration system Design Engineer shall have documented water and wastewater treatment and design experience for a minimum of fifteen (15) years.

E. Aerator assemblies and appurtenances shall be manufactured and designed according to the layout shown on the drawings. Aerators shall operate without objectionable noise or abnormal vibration. All rotating parts shall be balanced through precise CNC machining and precision rotor and shaft alignment. "Bolted-In", Piloted stub shaft assemblies are a requirement for each

F. Floating Brush Aerator. Any other form of rotor & shaft alignment or assembly is not acceptable. Aerators shall have a nameplate that will include the manufacturer's name, serial number, model number, size, gear reducer speed, and horsepower.

PART 2 - PRODUCTS

2.1 PRODUCT DESCRIPTION & MANUFACTURER

A. The Contractor shall furnish and install a total of three (3) 15hp Floating Brush Aerators and two (2) 10 hp Floating Brush Aerator as a part of this project. The Floating Brush Aerators shall be manufactured by ECS House Industries, Inc., Cherry Valley, Arkansas.

2.2 FLOATING BRUSH AERATOR ROTOR ASSEMBLY

A. The 15 hp floating brush aerator rotor shall have a 16” standard wall rotor pipe. The rotor shall be 98” in length. The rotor shall have 135 brushes that are 6" wide x 12.5" long. The brushes shall have a 133-degree V-shaped angle. The brushes shall be robotically welded, on both sides, in a spiral configuration to achieve superior balance and rotation. The rotor assembly shall be constructed of ASTM A36, TGIC Powder Coated Steel.

B. The 10 hp floating brush aerator rotor shall have a 8” standard wall rotor pipe. The rotor shall be 120” in length. The rotor shall have 95 brushes that are 6" wide x 14" long. The brushes shall have a 133-degree V-shaped angle. The brushes shall be welded, on both sides, in a spiral configuration to achieve superior balance and rotation. The rotor assembly shall be constructed of ASTM A36, TGIC Powder Coated Steel.

C. The rotor assembly shall have welded-in CNC machined inner plates that allow both the drive and non-drive end shafts the ability to be bolted-into the rotor. The bolt-in shafts are the “male” parts and the machined inner plates are the “female” parts. This is a definition of a piloted, bolt-in shaft assembly. A welded-flange on the outer diameter of the rotor pipe or torque tube with a bolted-on shaft is not acceptable. The drive and non-drive end shaft shall be fabricated from 316 stainless steel.

2.3 DRIVE TRAIN: DOUBLE-SEAL PROTECTION SYSTEM

A. The "Double-Seal Protection" (DSP) system prevents wastewater, solids in the wastewater, and corrosive wastewater gases from entering the drive-train enclosure. The DSP ensures that the drive-train (flange bearing, gear reducer, raptor coupler, & electric motor) will not be exposed to the elements described above. This type of protection system is a necessity for a floating brush aerator. Any floating brush aerator that does not have the DSP described below cannot be considered an equal and will not be an accepted manufacturer for this project or future projects.

B. The DSP system begins as the 316 stainless steel drive shaft enters the DSP enclosure through a seal plate. The 15hp floating brush aerator shall have a 2-15/16" diameter drive shaft. The 10hp floating brush aerator shall have a 2-7/16” diameter drive shaft

C. For the 15 hp Floating Brush Aerator, the piloted seal plate shall be CNC machined from ASTM A36, TGIC Powder Coated Steel. Internally, the 15hp drive shaft is supported by a 2-15/16” piloted flange bearing that is bolted internally to the DSP drive case with a spacer ring that permits a close fit and aligns the shaft seals.

D. For the 10 hp Floating Brush Aerator, the piloted-outer seal plates shall be CNC machined from 304L stainless steel. The outer seal plate shall have spring loaded, non-metallic, double-lip nitrile seals. Internally, the 10hp drive shaft is supported by a 2-7/16" piloted flange bearing that is bolted internally to the DSP drive case with a spacer ring that permits a close fit and aligns the shaft seals.

E. The piloted, flange bearing shall have a minimum L10 rating of 100,000 hours. The piloted, flange bearing and gear reducer output hub bearings support the weight of the drive-end rotor assembly.

F. A battery operated "Perma-Lube Grease Feeder" (PLGF) shall be provided with each floating brush aerator to lubricate the piloted, flange bearing and non-drive end bearing. The PLGF provides grease to the bearing as needed for a six (6) month period. The PLGF requires a manual grease & battery refill & replacement. The frequency for this refill is located in the O&M Manual

G. The motor bracket bolts directly to the DSP housing to provide room for installation and removal of the shaft mounted gear reducer. The motor is sealed to the TSP housing with silicone. This assembly ensures that the C-Face motor can be removed without having to reposition the gear reducer.

H. The powder coated steel cover of the DSP housing shall be held closed with two stainless steel clamp latches mounted on stainless steel blocks bolted to the DSP housing sides. The latching force shall be adjustable to maximize sealing of the cover. The stainless steel clamp catches shall be bolted to the DSP cover flange. When in the raised position for service and inspection, the cover shall be held open with manually inserted stainless steel pins with lanyard in the hinge linkage.

I. The DSP housing shall be bolted to the framework in four (4) places provided by four (4) angle brackets bolted to the DSP housing sides.

2.4 SPLASH-SHIELD PROTECTION SYSTEM

A. House Industries' Splash-Shield Protection System (SPS) eliminates wastewater debris from penetrating and damaging drive components. The SPS also keeps the wastewater from splashing on the drive and non-drive end of the Floating Brush Aerator.

B. The SPS includes 304L stainless steel splash shields and a 304L stainless steel, shrouded seal system equipped with a covered slinger to ensure debris and wastewater do not damage drive components.

2.1 GEAR REDUCER

A. The gear reducer shall be a constant-duty AGMA Class III DODGE gear reducer. The gear reducer shall be directly mounted to the rotor assembly's drive shaft with a tapered-bushing

assembly. The shaft mounted helical gear reducer shall have tapered roller bearings. Ball bearings in the gear reducer are not acceptable. The gear reducer shall produce a nominal rotor speed of 70 rpm.

B. The 15hp floating brush aerator will have the DODGE TA4 model gear reducer. The TA4 gear reducer shall be rated for 32.6hp @ 1750 RPM input speed, providing a minimum 2.0 service factor.

C. The 10hp floating brush aerator will have the DODGE TA3 model gear reducer. The TA3 gear reducer shall be rated for 21.0hp @ 1750 RPM input speed, providing a minimum 2.0 service factor

D. The input shaft and output hub seals shall be non-corrosive, non-metallic, stainless steel spring loaded double lip, nitrile seals. The output hub shall have two seals on each side.

E. A cooling fan shall be mounted to input shaft of the gear reducer. A keyed hub on the input shaft will provide rotating power for the fan.

2.2 PARAFLEX COUPLING

A. The input shaft of the gear reducer shall be connected to the motor shaft with a Dodge Raptor Coupler. This direct-driven assembly between the electric motor and gear reducer via a Raptor coupler provides a “Dampened Drive System” (DDS). The DDS absorbs start-up forces and allows for 4° of misalignment. The coupler shall be high speed and the coupler element shall be constructed of high density reinforced rubber. The gear reducer shall not be connected to the motor using any type of V-belt driven system or a “low speed coupled” direct driven system.

B. The 15hp floating brush aerator uses an E20 Dodge Model Raptor Coupler.

C. The 10hp floating brush aerator uses an E5 Dodge Model Raptor Coupler.

2.3 ELECTRIC MOTOR

A. Each floating brush aerator shall use a premium efficiency, severe-duty C-face motor with mounting feet.

B. The motors for 15 hp Floating Brush Aerator shall be 15hp, 3-phase, 60 Hertz, 230/460 volt, 1750 RPM with a 1.25 operating service factor when motor is operating at 90% of rated full load during normal operation.

C. Motor shall be totally enclosed, fan cooled (TEFC), rated for severe corrosive-duty, NEMA Class F insulation, cast iron construction with an epoxy coating, and stainless steel hardware and nameplate. (Premium efficiency; meets or exceeds the requirements of EPACT '92 and Canadian Federal Efficiency Levels defined in CSA C390-93. Full load efficiency of all ratings is certified under the EEV Program of the CSA.)

2.1 ELECTRIC MOTOR CERTIFICATION

A. The aerator manufacturer shall provide certification that the nameplate data affixed to the aerator's electric motor is valid, specific data applicable to that particular motor

2.2 NON-DRIVE END ROTOR BEARING

A. The non-drive end bearing shall be a grease lubricated, stainless steel, eccentric collar, ball-bearing assembly. The bearing shall have a 304L stainless steel inspection cover and an auxiliary, non-corrosive seal mounted in a 304L stainless steel seal plate on the rotor assembly side of the non-drive end bearing bracket.

B. The eccentric collar shall have a stainless steel, rear cover mounted above and around the non-drive end bearing bracket sides.

C. The bearing shall have an L10 bearing life over 100,000 hours.

D. A “Spring Loaded Grease Feeder” (SLGF) shall be provided with each floating brush aerator to lubricate the non-drive end bearing. The SLGF provides grease to the bearing as needed. The SLGF requires a manual grease refill. The frequency for this refill is located in the O&M Manual.

E. Plastic bearings that may or may not use wear sleeves or bushings will not be acceptable. Water lubricated bearings are also not acceptable.

2.3 FLOATATION ASSEMBLY

A. Each floating brush aerator shall have (2) two, 16 gauge, 304L stainless steel tanks. All stainless steel floats shall be seam welded and pressure checked after fabrication. The stainless steel floats shall be foam filled with “closed celled” two part foamular foam.

B. The 15hp drive-end tanks shall be: 5’ x 29” & 4’ x 16” (length & diameter) and the non-drive end tank shall be 12’ long x 26” diameter.

C. The 10hp drive-end tanks shall be two (2) 4' x 29" diameter, and the non-drive end tank shall be 10' long x 26" diameter.

2.4 FLOATATION ATTACHMENT BANDS

A. Each floatation tank shall be attached to the floating brush aerator mainframe using 304L stainless steel bands. The bands are connected to the mainframe with stainless steel pins and 304L stainless steel bolted brackets. The mainframe shall be connected to the anchoring system in such a manner that external forces, resulting from wave action and other external movement, are not transferred to the floatation attachment bands.

B. Each floatation tank shall have adjusting linkage attached to each corner of the aerator main frame. Adjusting linkage shall be capable of changing the operating depth of the horizontal rotor blades; the horsepower requirement and amperage draw, and provide aerator leveling. Adjusting linkage shall be fabricated from 304L stainless steel rods with brass adjusting nuts. Adjusting linkage shall not be connected directly to the anchoring system nor shall it mechanically depend upon the anchoring system for it to be effective.

2.1 AERATOR MAIN FRAME

A. The main frame of the aerator shall be fabricated from ASTM A36 TGIC Powder Coated Steel, and shall use 4" schedule 40 pipe & 3/16" plate. The frame shall be welded and bolted together with stainless steel hardware.

2.2 ANCHORING SYSTEM

A. The anchoring system shall meet the requirements indicated in the Meteorological and Seismic Design Criteria section.

B. The anchoring system shall hold the aerator firmly in position. The type of anchoring system to be used is determined by the placement of the floating brush aerator(s), and the wastewater application.

C. The anchoring system shall be fabricated from 304L stainless steel or TGIC Powder Coated, Mild Steel. The anchoring system shall not restrict the unit's floatation and shall allow for continuous aerator operation with fluctuations in the water surface elevation up to (plus/minus) three feet (±3ft.).

D. The anchoring system for this lagoon application shall consist of two (2) parallel mooring arms, one (1) cross-brace assembly, and two (2) vertical bank stake poles in order to anchor to the levee of the lagoon.

2.3 POWDER COATING SPECIFICATIONS

A. GENERAL: As an ALTERNATE to a 100% STAINLESS STEEL FLOATING BRUSH AERATOR manufactured by ECS House Industries, Inc., the following aerator part(s) and/or assemblies can be manufactured from ASTM A36 Mild Steel, and Powder Coated after the part(s) and/or assemblies are completely fabricated. The remaining aerator parts(s) and/or assemblies shall be manufactured from stainless steel.

a. Rotor Assembly: This includes rotor pipe, brushes, drive and non-drive end shafts, and machined, rotor inner plates.
b. Triple Seal Protection Housing: This includes the entire TSP case, cover, housing, and inner & outer seal plates
c. Aerator Main Frame: This includes the pipe and plate material for the aerator main frames.

A. Powder Paint Description: All metals that have been specified to be TGIC Powder Coated shall follow the process below in order to achieve a superior coating system. Polyester TGIC coatings utilize the epoxy functional cross-linker TGIC (triglycidylisocyanurate). Use of this low molecular weight, multifunctional cross-linker enables polyester TGIC formulations to contain 90% or greater resin within the binder system. All powder coating shall use this type of TGIC formulation with a minimum thickness of three (3) mils.

B. Metal Shot-Blast Process: The cleaning process shall begin with the steel components being steel shot blasted to an SSPC-6 commercial gray quality (Manual steel shot blast for touch up if required). The BCP shot blast room is utilized for compressed air cleaning to remove shot from crevices and horizontal surfaces of steel components.

C. Four-Stage Wash: The components then shall enter a four (4) stage batch washing system consisting of:

1. Combination Cleaner Phosphate Coater 180 seconds

2. 1st Fresh Water rinse 120 seconds

3. 2nd Fresh Water rinse 60 seconds

4. Non-chrome seal rinse 60 seconds

D. Batch Dry-Off: The metal part (s) shall dry in the IHEI batch dry-off oven at 225-degree Fahrenheit to flash off any moisture remaining on the steel components.

E. Electrostatic Application: Electrostatic applications of TGIC powders are manually applied in an environmental room that controls humidity at less than 50%. The environmental room shall have a grounded booth for the applications of TGIC powder.

F. Powder Curing: Curing of these components shall be accomplished in a 450-degree maximum temperature curing oven. The oven has three load bar locations to permit proper curing time that may vary from 40 to 55 minutes (these times are dependent on metal thickness).

G. Quality Control: Coating thickness shall be checked prior to unloading the steel components with a thickness meter. If the proper thickness is not met (3 mils minimum), the steel components go to an 850-degree F oven where the powder-paint is burned off and easily removed from the metal. After this, the metal goes through the system again.

2.4 SERVICE CONDITIONS

A. The floating aeration equipment shall be designed to aerate and completely mix wastewater and activated sludge under the following service conditions:

Seismic design requirements and site elevation.	See Meteorological and Seismic Design Criteria section.	
Ambient air temperature range.	40 to 90	°F

Average flow.	0.9	mgd
Maximum flow (weekly maximum).	2.7	mgd

B. Minimum velocity in the lagoon shall provide mixing of dissolved oxygen. The aerators will operate continuously.

C. Equipment furnished under this section shall be designed for outdoor use, unprotected from the exposure to the atmosphere. The equipment shall be designed for humid atmospheric conditions with an ambient air temperature range indicated, and shall be designed for continuous operation.

2.5 PERFORMANCE AND DESIGN REQUIREMENTS

A. Each floating surface aerator shall operate independently and shall be controlled from a motor control center. The aerators shall agitate the surface, completely mix the contents, transfer oxygen, and induce circulation of liquid throughout the Lagoon.

Condition	Peak Day Summer	Maximum Month Summer	Annual Average	
Plant flow to Lagoon		1.5	0.8	mgd
BOD concentration to aeration Lagoon.		591	199	mg/L
BOD loading to Lagoon		5,584	1,318	ppd

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Equipment Installation section.

3.2 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust as necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

B. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

C. Installation supervision and start-up services shall be provided only to the extent required to comply with the manufacturer’s warranty conditions.

D. After completion of the equipment installation, testing of the floating brush aerators shall be done continuously for a period of 24 hours.

E. All costs for these services shall be included in the contract price.

3.3 PERFORMANCE TESTING

A. Submit a recent standard aeration efficiency (SAE) test report for the proposed brush aerator demonstrating compliance with the specified oxygen transfer performance requirements.

End of Section

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Pump & Process Equipment
300 Shadow Wood Park
Birmingham, AL 35244

PUMP & PROCESS
Equipment Incorporated

Phone: 205-987-3337
Fax: 205-987-3622
info@pumpandprocess.net

Monday, September 14th, 2026

To: **Interested Contractors**

From: **Scott Emfinger**
Pump & Process Equipment, Inc.

Date: **September 14, 2026**

Project: **Bridgeport, AL Aeration Upgrade**

ECS House Industries' Floating Brush Aerators provide effective and efficient wastewater treatment through superior oxygen transfer and mixing rates. The ECS House Industries' Floating Brush Aerators have a Standard Aeration Efficiency of 3.0 lbs.02/hp/hr and mixing rates over 3,500 gpm/hp. The oxygen transfer and mixing rates described above are 25% to 40% better than other styles of surface aeration systems.

The House Brush Rotor design has been utilized in wastewater treatment plants for over 35 years and has proven to be the industry leader in Floating Brush Aerator Technology.

ECS House Industries, Inc., represented by Pump & Process Equipment, Inc. would like to offer the following Floating Brush Aeration Equipment Proposal. We meet and exceed all specification requirements.

Three (3) 15hp & Two (2) 10hp, Stainless Steel, Floating Brush Aerators include:

Rotor Assembly (including brushes), Aerator Main Frame, Drive Enclosure, **Mooring System, from304L Stainless Steel.

Foam Filled Floatation Tanks, Floatation Band Attachments, Non-Drive End Bearing Cover, Splash Shields, Electric Motor Cover are made out of 304L Stainless Steel.

Drive End and Non Drive End Shafts will be made out of 316L stainless steel.

Further detailed build characteristics and materials details are in the aerator specifications.

**The Mooring System shall consist of two (2) 18' mooring arms, one (1) cross brace assembly, and two (2) mooring arm anchoring attachments for levee anchoring.

Process Performance & Aerator Operations:

- 15hp, ECS House Industries, Inc. Floating Brush Aerator shall produce 40.5 lbs.02/hr
- 10hp, ECS House Industries, Inc. Floating Brush Aerator shall produce 27 lbs. O2/hr
- ECS House Industries, Inc. Floating Brush Aerators shall produce a minimum pumping rate of 3,500 gpm/hp
- ECS House Industries, Inc. Floating Brush Aerators will meet all process performance requirements\
- ECS House Industries, Inc. will meet and exceed all specifications.

Delivery:

- ECS House Industries, Inc. can guarantee delivery 4-6 weeks after receipt of approved purchase order agreement

Start-Up & Training Procedures:

ECS House Industries, Inc. will complete a startup/warranty certification that will help train plant personnel how to properly maintain the Floating Brush Aerators. The startup will include the following:

- Proper oil changing procedure & oil change frequency
- Proper grease lubrication procedures & lubrication frequencies
- Raptor Coupler alignment & replacement
- Drive & Non-Drive End Bearing replacement
- Review Aerator set-up & trouble shooting guide
- Visual aerator inspection: seal surfaces, bearings, & shafts
- Rotor & blade depth adjustment
- After aerator start-up, the Contractor/Representative/or Owner will check the Floating Brush Aerators for proper rotor assembly rotation, and the amperage draw of each electric motor. Each electric motor shall operate at a suggested 90% load based on the nameplate data.
- If any rotor assembly adjustments are necessary to improve the amperage draw and aerator performance, then this adjustment shall be performed in strict accordance to "Aerator Set-Up & Trouble Shooting Guide" provided by ECS House Industries, Inc.
- After Floating Brush Aerators are operating properly, ECS House Industries shall provide documentation reports to the Contractor and Operator certifying the Floating Brush Aerators are operating properly.
- Online Webinars are available to further assist in any start-up and/or training.

Warranty:

ECS House Industries, Inc. will warranty its equipment as free of defects in material and workmanship for a period of twenty-Four (24) months to the original purchaser subject to the restrictions and conditions listed herein. Warranty period will begin upon delivery to the original purchaser or its designee. ECS House Industries, will replace or repair any part built and manufactured by ECS House Industries, Inc. within the warranty period that have failed under normal use subject to the restrictions and conditions listed herein. **1st year Preventative Maintenance will be performed by ECS House Industries, Inc. Service Technicians at no charge to the Owner.**

Pricing:

Three (3) 15hp, ECS House Industries, Inc. Floating Brush Aerators, Model #SDB120TA4SS

Two (2) 10hp, ECS House Industries, Inc. Floating Brush Aerators, Model #SDB120TA3SS

*Freight
Included
*Start-Up & Warranty Certification
Included
*Pricing does not include state and/or local taxes
*Freight is subject to change

Grand Total: $ 243,500

Deduct for Alternate, Mild Steel Powder Coated/Stainless Steel 10hp: $ 2,725 each aerator

Deduct for Alternate, Mild Steel Powder Coated/Stainless Steel 15hp: $ 5,100 each aerator

If you have any further questions and/or comments, then please contact us for assistance. Thank you for the opportunity to become your Wastewater Treatment partner

Scott Emfinger
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205-987-3337 office
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TERMS AND CONDITIONS

1. GENERAL - The conditions of sale outlined herein (hereinafter referred to as 'these conditions') and attached hereto, apply to the sale by Pump & Process Equipment, Inc. (the "Company"), of products, equipment and parts thereto (hereinafter referred to as "Equipment"). In the event the Purchaser issues a letter of authorization to proceed or a purchase order number for the equipment or work intended to be covered by these conditions prior to a resolution of agreeable contract provisions, it will be understood that the Company's proceeding under such authorization will be in accordance with the conditions outlined herein. The Company will not be bound by any contract or modifications of the conditions until approved in writing by the Company.

2. GOVERNING LAW - These conditions shall be construed in accordance with the laws of the State of Alabama, and the respective rights and obligations of the Purchaser and Company will be governed by the laws of the State of Alabama.

3. TITLE AND RISK OF LOSS - Title and risk of loss or damage to the equipment will pass to the Purchaser after delivery to the transportation facility at F.O.B. point. Purchaser agrees that the Company will retain a security interest in the Equipment only until the purchase price has been fully paid and Purchaser agrees to perform all acts necessary to protect and assure that security interest.

4. DELIVERY - Delivery dates quoted by the Company are approximate and will not be construed as creating a situation where "time is of the essence" unless the parties specifically agree to the contrary in writing. The Company will not be liable for loss, damage, detention or delay due to war, riots, civil insurrection or acts of the common enemy, fire, flood, strikes, or other labor difficulty, acts of civil or military authority including, without limitation, governmental laws, orders, priorities or regulations, acts of the Purchaser, embargo, car shortage, wrecks or delay in transportation, inability to obtain necessary labor, materials or manufacturing facilities from unusual sources or other causes beyond the reasonable control of the Company. In the event of delay in performance due to any such cause, the date of delivery or time for completion will be adjusted to reflect the delay. The Purchaser's acceptance of Equipment will constitute a waiver of any claims for delay.

5. CREDIT APPROVAL/PAYMENTS - This contract shall be subject to approval and acceptance by the Company. If, in the sole judgement and discretion of the Company, the terms of payment requested by Purchaser in the following paragraph shall not be sufficient to assure the Company of timely payment of the purchase price stated for this contract, the Company may require full or partial payment in advance, or other modifications to the terms of payment requested in the following paragraph. Such modifications shall not be binding upon Purchaser until such are accepted by Purchaser. If shipments are delayed by Purchaser, payment shall become due from the date when the Company is prepared to make shipment as stated in the contract. Equipment held for Purchaser beyond the shipping date shall be held at the risk and expense of Purchaser. Special permits and/or risk of loss or damage in transit shall be the responsibility of Purchaser. Equipment price does not include any required taxes or permits, and Purchaser specifically agrees to reimburse the Company for any such permit fees or other charges which it is required to pay on behalf of Purchaser. Purchaser is specifically responsible for obtaining permits in connection with the sale and/or installation of equipment sold on this contract.

6. TERMS WITH SECURITY (Bond, Letter of Credit, etc.) - 95% of total contract price 30 days from date of invoice or at start-up, whichever occurs first, with remaining5% due within 10 days of Company start-up or 30 days from shipment, whichever occurs first. Start-up to occur no later than 60 days from delivery.

TERMS WITHOUT SECURITY - 25% with order, 70% upon delivery, 5% at start-up.
For either payment option, the quoted price is based on full payment within a maximum of thirty (30) days from shipment. Any balances remaining due sixty-one days beyond the invoice date will be subject to an additional one and one-half (1½%) percent monthly service fee until paid. Should the Company have to engage an attorney to collect the balance due including the handling charge and service fee, Purchaser agrees to reimburse the Company for all collection costs including attorney's fees.

7. TAXES - It will be the responsibility of the Purchaser to pay sales taxes direct to the applicable taxing authority. The Company does not assume this responsibility.

8. LIMITATION OF LIABILITY - The Company will not be liable for any damages for any reasons sustained by anyone resulting from the failure of the Company, or any other supplier's failure to perform or delay in performing any obligation hereunder if such failures or delays are caused directly or indirectly by circumstances or events beyond the control of the Company. Such events include, but are not limited to, invasion, insurrection, riot, fire, flooding, strikes, or the failure of any supplier or trucker to meet scheduled delivery dates. Furthermore, Purchaser specifically agrees to waive any right to incidental or consequential damages as stated in the warranty given by the Company, and as further agree.

9. LIMITATION OF ACTION - No action shall be brought against the Company, for any breach of warranty, whether written or implied, or for breach of its contract of sales more than eighteen (18) months after the accrual of the cause of action thereof, and in no event, unless Purchaser shall first have given notice to the Company, of any claim of breach of contract, or breach of warranty, whether written or implied.

10. BACK CHARGES - Purchaser specifically agrees that the Company will not be responsible for any "backcharges" or other costs and expenses unless and until Purchaser first obtains written approval from the Company for such backcharges, cost or expenses.

11. LIMITATION OF DAMAGES - Purchaser specifically agrees that the Company is not responsible for any damage and/or injury which may result from improper handling during shipment, installation, repair or maintenance of the equipment. In addition, the Company will not be responsible for damage to Purchaser's property, or the property of others, whether real or personal, caused by malfunction of the equipment.

12. CLAIMS - All claims for shortages or defective equipment shall be made in writing with fifteen (15) days after receipt of such equipment, and such claims shall, in no event, include allowance for labor or incidental or consequential damages. Equipment may not be returned to the Company without it's written consent and under no circumstances will the Company be responsible for damage beyond the cost of the goods sold.

13. ACCEPTANCE - After acceptance by the Company, Purchaser's orders are not subject to cancellation, change, reduction in amount, or suspension of delivery, without the advance written consent of the Company. It is specifically agreed the Company will be under no obligation to give such consent without first having been reimbursed for all costs incurred, including, but not limited to, engineering time, administrative costs, restocking charges, including overhead, cost of materials, cost of storage and profit. The Company may cancel the order prior to or at the time of receiving the final approved drawings if the Company deems itself to be insecure or determines that it is commercially unreasonable to proceed. In the event of cancellation by the Company, all deposits made by Purchaser shall be refunded in full.

14. INDEMNITY - Purchaser specifically agrees to indemnify and hold the Company harmless from any and all claims, demands, and causes of action in any way arising out of the improper transportation, installation, storage, handling, maintenance, or operation of said equipment occurring after the equipment is shipped and for any damage to the equipment or other property resulting from induction into the equipment or exposure to corrosive elements which the equipment is not designed to handle. Such obligation shall include reimbursement for any and all fees and expenses incurred by the Company, including attorney's fees.

15. WARRANTIES - No representation or statements have been made by the Company concerning the equipment to be sold hereunder, except as is stated herein, and no warranty, expressed or implied, arises apart from the written warranty from the Manufacturer.

16. INSURANCE - On and after the date on which risk of loss shall shift from the Company, or the manufacturer from which equipment is shipped, to Purchaser hereunder and until the full purchase price shall be paid, Purchaser will insure the goods against all hazards in form and amounts and with an insurer satisfactory to the Company. If Purchaser fails to obtain insurance, the Company shall have the right, but not the obligation, to obtain such an insurance at Purchaser's expense, without waiver of any other remedy, and Purchaser assigns to the Company all rights to receive proceeds of insurance not exceeding the unpaid balance due hereunder including any costs of collection, attorney's fees or other costs actually incurred in connection herewith. Purchaser specifically directs any insurer to pay all proceeds directly to the Company, and authorizes it to endorse any draft for proceeds. In the event of damage to the equipment and payment of insurance thereof, the Company shall have the option of replacing the goods or applying the proceeds on any obligation secured hereby.

17. EXCLUSIVE STATEMENT - This writing contains the full, final and exclusive statement of the contract between Purchaser and the Company and no agreement or warranty, except as contained herein, shall be binding on the Company. The terms and conditions set forth herein may not be modified, supplemented, expanded, or waived, by parol evidence, Purchaser's purchase order, course of dealing or in any other way, except where made in writing and signed by Purchaser and the Company.

ACCEPTED BY:

Purchaser's Authorized Signature	Date
Title	PPEI Project No.
Company Name (Purchaser)	
Project Name	Purchase Order No.