



Nisqually Indian Tribe

Kalama Creek Hatchery Rebuild - Phase 2

EDA Award #: 07 79 07880

**Construction Documents
Project Manual**

Record

May 9, 2023

HDR Project No. 10176455



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DIVISION 00

PROCUREMENT AND CONTRACTING REQUIREMENTS

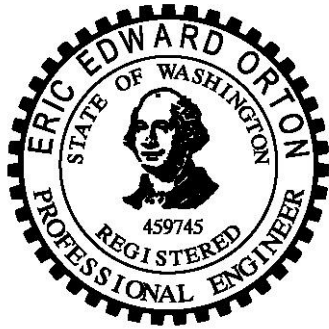


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00 01 07

SEALS AND SIGNATURES

Owner Name: Nisqually Indian Tribe
Facility or Site Name: Kalam Creek Hatchery
Project Name: Kalama Creek Hatchery Rebuild; Phase II
Tribe Project Number: 10176455
Engineer: HDR Engineering, Inc.



The seal and signature to the left applies to the following Specifications divisions and sections of this project manual:

Process Mechanical



John D. Nelson, PE
License No. 39603

The seal and signature to the left applies to the following Specifications divisions and sections of this project manual:

Civil

	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: Structural
	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: Process Mechanical
	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: Architectural

	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: Electrical

It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this project manual.

END OF SEALS AND SIGNATURES

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ADVERTISEMENT FOR BIDS

NISQUALLY INDIAN TRIBE

KALAMA CREEK HATCHERY REBUILD

Nisqually Indian Tribe Project No 10176455

This Contract provides for the renovation of the Kalama Creek Hatchery Rebuild and other work, all to be constructed in accordance with the plans and specifications as prepared by The Nisqually Indian Tribe (Tribe) and HDR Engineering, Inc. (Engineer).

Project Base Bid Estimate Range: \$3,500,000.00 to \$4,250,000.00

All bid proposals shall be accompanied by a bid proposal deposit in cash, certified check, cashier's check or surety bond in an amount equal to five percent (5%) of the amount of such bid proposal. Should the successful bidder fail to enter into such contract and furnish satisfactory contract bond within the time stated in the specifications, the bid proposal deposit shall be forfeited to the Tribe.

Complete digital project Bidding Documents are available at the website provided in the RFP. Partial sets of Bidding Documents will not be available. Neither the Tribe nor Engineer will be responsible for full or partial sets of Bidding Documents, including Addenda, if any, obtained from sources other than listed above. Project questions should be directed to Chad Wall, MPA, Senior Project Manager of Nisqually Building Department at 360-456-5221.

The designated website (listed above) will be updated periodically with Addenda, lists of registered Bidding Documents holders, reports on the Site, and other information relevant to submitting a Bid for the Project. All official notifications, Addenda, and other Bidding Documents will be offered only through the designated website. Neither Tribe nor Engineer will be responsible for Bidding Documents, including Addenda, if any, obtained from sources other than the designated website.

All bids shall be received by date indicated on RFP on the bid opening date. Bids will be collected from the Nisqually Tribal Center at 4820 She Nah Num Drive S.E., Olympia, WA 98513 and together with any mailed bids will be opened by the Tribe at the Tribal Center. Should a bid summary be provided it will be posted to the Tribes construction web page.

Pre-bid Site Visit

A non-mandatory pre-bid site walk will be held on the date indicated in the RFP. The site walk will be held at Kalama Creek Hatchery located at 13650 Peter Kalama Dr., Olympia, WA 98513. Attendance at the pre-bid site walk is encouraged but not required.

Bidders Questions/Request for Interpretation

Bidders' questions and/or request for interpretation regarding the Bidding Documents will not be accepted after final Bidding RFI submission date posted in RFP.

Instructions to Bidders

The Bidder's attention is called to the "Notice of Requirement for Affirmative Action To Ensure Equal Employment Opportunity" (Executive Order #11246) contained in the bid documents,

which sets forth, in part, the goals and timetables for the employment of women and minorities in the project area. In addition, the Project is subject to Indian preference in contracting and hiring. Contractors must apply every “good faith effort” to see that minorities, Native Americans and women comprise a portion of each construction trade on this project and to the maximum extent feasible, lower income persons are given employment opportunities and businesses in the community are given contracting opportunities on this project.

Native American preference in awarding the project by the Nisqually Tribe is to support and encourage Indian business participation to the greatest extent possible without incurring unwarranted project cost. Indian business participation preference will be given to bidding Contractors in the following priority:

1. If a non-Nisqually Indian owned business¹ submits a responsive bid within 2% of the resultant lowest responsive bid, then the project may be awarded to the non-Nisqually Indian owned business even if it did not submit the lowest bid.
2. If a non-Indian owned business who uses minimum 10% participation of Native American subcontractors² submits a responsive bid within 2% of the resultant lowest responsive bid, then the project may be awarded to the non-Indian owned business even if it did not submit the lowest bid.

Contractor shall comply with the Equal Employment Opportunity Act, September 28, 1964, No. 11246, all United States Department of Labor Regulations and Standards Title 29, 1,2 and Title 18 U.S.C. Section 874 known as “Anti-Kickback Act,” and the Federal Occupational Safety and Health Act of 1970.

The bidding documents contain the current Davis-Bacon Wage Rates. The Contractor must pay the higher amount between the federal Davis-Bacon and state prevailing wage rates. The Davis-Bacon rate are current as of 10-days prior to the bid opening will be applicable to this contract.

Be advised that is EDA award contains the “Buy America” provision and to the greatest extent practicable, contractors are encouraged to purchase American-made equipment and products with the funding provided.

¹ An Indian owned business is defined as having a minimum 51% ownership by a recognized Indian Tribe or a member of recognized Indian Tribe in the United States of America.

² A “Native American subcontractor” shall be an “Indian owned business” as defined above.

For all further requirements regarding bid submittal, requirements, procedures, and contract award, refer to the Instructions to Bidders that are included in the Bidding Documents.

The Tribe reserves the right to reject any or all bids and proposals.

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. Nisqually Indian Tribe- *Tribe*
 - B. *HDR Engineering, Inc. – Engineer*

ARTICLE 2—BIDDING DOCUMENTS

- 2.01 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding 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.
- 2.02 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, nor does it grant or confer ownership or any property interest in the Bidding Documents and other documents distributed for the Project. Authorization to download documents, or other distribution, includes the right for Bidding Documents holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the Bidding Documents holder pays all costs associated with printing or reproduction. Paper or other types of printed documents may not be re-sold under any circumstances.
- 2.03 Bidder may register as a Bidding Documents holder and obtain complete sets of Bidding Documents, in the format stated in the Advertisement or invitation to bid. Registered Bidding Documents holders will receive Addenda issued by Engineer.
- 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 prospective Bidders as Electronic Documents in the manner specified.
 - 1. Bidding Documents will be provided in Adobe PDF (Portable Document Format) (.pdf). It is the intent of the Engineer and Tribe that such Electronic Documents are to be exactly representative of the paper copies of the documents. However, because the Tribe and Engineer cannot totally control the transmission and receipt of Electronic Documents nor any bidder's or the Contractor's means of reproduction of such documents, the Tribe 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 2.06.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 paper versions of the documents, and for Bidder's reliance upon such derived information.

ARTICLE 3—RESPONSIBLE BIDDERS

- 3.01 Prospective Bidders must submit required information indicating they are responsible concurrent with bid submittal. Tribe will review the submitted information to determine if bidders meet the minimum responsible bidder requirements presented in Section 00 45 13 Responsible Bidder Criteria. Bids will only be accepted from registered contractors meeting the minimum responsible bidder requirements. The information that each prospective Bidder must submit to seek responsible provided in Section 00 45 13 Responsible Bidder Criteria.
- 3.02 This project will be partially funded with Federal funds from the United States Department of Commerce, Economic Development Administration and therefore is subject to the Federal laws and regulations associated with that program.
- 3.03 The Tribe may make such investigations as deemed necessary to determine the ability of the Bidder to perform the Work, and the Bidder shall furnish to the Tribe all such information and data for this purpose as the Tribe may request. The Tribe reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Tribe that such Bidder is properly responsible to carry out the obligations of the Agreement and to complete the Work contemplated therein.
- 3.04 A conditional or qualified Bid will not be accepted.
- 3.05 Bidder is to submit the following information with its Bid to demonstrate Bidder is responsible to perform the Work:
 - A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.
 - B. A written statement that Bidder is authorized to do business in the State of Washington, or a written certification that Bidder will obtain such authority prior to the Effective Date of the Contract.
 - C. Bidder's state (or other) contractor license number, if applicable.
 - D. Subcontractor and Supplier qualification information including names and addresses.
 - E. Other required information regarding indicating the Bidder is responsible (see Section 00 45 13 Responsible Bidder Criteria).

- 3.06 A Bidder's failure to submit required responsible bidder information within the times indicated may disqualify Bidder from receiving an award of the Contract.
- 3.07 No requirement in this Article 3 to submit information will prejudice the right of Tribe to seek additional pertinent information to determine if the Bidder is responsible.

ARTICLE 4—PRE-BID CONFERENCE

- 4.01 A non-mandatory virtual pre-bid conference and non-mandatory in-person site walk will be held at the time and location indicated in the Advertisement for Bid. Representatives of Tribe and Engineer will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference; however, attendance at this conference is not required to submit a Bid.
- 4.02 Information presented at the pre-bid conference does not alter the Bidding Documents. Engineer will issue Addenda to make any changes to the Bidding 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—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

- 5.01 *Express Representations and Certifications in Bid Form, Agreement*
- 5.02 The Bid Form that each Bidder will complete and submit contains express representations regarding the Bidder's examination of project documentation, in-person site visit (not required) interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all Bidding Documents holders registered with Engineer. Questions received less than seven days prior to the date for opening of Bids may not be answered.
- 5.03 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 Bidding Documents.
- 5.04 Addenda that Engineer judges to have a material or significant effect on Bidders' preparation of pricing and other requirement element of the Bid will be posted at [????] for Bidders' receipt not less than three days prior to the scheduled date for receipt of the Bids. Clarifications or modifications that Engineer deems will not have a material or substantial effect on the preparation of Bids may be transmitted for Bidders' receipt later, for receipt prior to the deadline for receipt of Bids.

ARTICLE 6—BID SECURITY

- 6.01 *Required Form and Amount of Bid Security*
 - A. A Bid must be accompanied by bid security made payable to Tribe 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.

- B. Such bid bond will be issued in the form included in the Bidding Documents.

6.02 *Bid Security of Successful Bidder*

- A. The Bid security of the apparent Successful Bidder will be retained until Tribe awards the Contract to such Bidder, and such Bidder has signed the Contract, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Successful Bidder's bid security will be released.
- B. If the Successful Bidder fails to sign and deliver the Contract and furnish the required Contract security within the number of days, indicated in Paragraph 20.01 of these Instructions to Bidders, after the Notice of Award, Tribe may consider Bidder to be in default, annul the Notice of Award, and the bid security of that Bidder will be forfeited.
- C. Upon Successful Bidder's default:
 - 1. The entire penal sum amount of the bid bond will be forfeit and due Tribe.
- D. Such forfeiture will be Tribe's exclusive remedy if Bidder defaults.

6.03 *Bid Security of Bidders other than the Successful Bidder*

- A. The bid security of other Bidders that Tribe believes to have a reasonable chance of receiving the award may be retained by Tribe until the earlier of seven days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon bid security furnished by such Bidders will be released.
- B. Bid security of other Bidders that Tribe believes do not have a reasonable chance of receiving the award will be released within seven days after the bid opening.
- C. Release of Bid Security: Tribe may release any Bidder's bid security by returning such bid security to the associated Bidder. When bid security is in the form of a bid bond, Tribe may dispose of or destroy the bid bond and so advise the associated Bidder in writing that the bid bond has been released.

ARTICLE 7—CONTRACT TIMES

- 7.01 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.
- 7.02 Provisions for liquidated and special 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 8—SUBSTITUTE AND “OR EQUAL” ITEMS

- 8.01 The Contract for the Work, as awarded, will be on the basis of materials, equipment, and procedures specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or “or-equal” items or procedures. 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 or

procedure, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

- 8.02 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, and will perform the Work in accordance with procedures indicated in the Bidding Documents, as supplemented by Addenda, if any. Assumptions regarding the possibility of post-bid approvals of “or-equal” or substitution requests are made at Bidder’s sole risk.

ARTICLE 9—SUBCONTRACTORS, SUPPLIERS, AND OTHERS

- 9.01 All bidders shall submit the Subcontractors List provided in Section 00 45 13 one-hour after the bid opening if the Subcontractor List is not submitted with the bid. The one-hour time duration will begin at the conclusion of the virtual bid broadcast. If the Subcontractor List is not submitted with the bid email it to Eric.Orton@hdrinc.com. Subcontractors shall be provided for the following portions of the Work:
- 9.02 If requested by Tribe or Engineer, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence indicating each such Subcontractor or Supplier are responsible. If Tribe or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor or Supplier, Tribe 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 shall not be increased cost occasioned by such substitution, and Tribe may consider such price adjustment in evaluating Bids and awarding the Contract.
- 9.03 If apparent Successful Bidder declines to make a requested substitution, Tribe may award the Contract to another Bidder, consistent with the basis for evaluating the Bids for award as set forth in these Instructions to Bidders, 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 Tribe or Engineer makes no written objection prior to issuance of the Notice of Award will be deemed acceptable to Tribe and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.

ARTICLE 10—PREPARATION OF BID

- 10.01 The Bid Form is included with the Bidding Documents.
- A. All blanks on the Bid Form must be completed in ink or typewritten and the Bid Form signed in ink, Bid form must be fully completed and executed when submitted. 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. Only one copy of the Bid form is required.

- 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.”
- 10.02 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 8.5-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 Tribe 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.
- 10.03 A Bid by a corporation must be signed 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.
- 10.04 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.
- 10.05 A Bid by a limited liability company must be signed 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.
- 10.06 A Bid by an individual must show the Bidder’s name and official address.
- 10.07 A Bid by a joint venture must be signed by an authorized representative of each 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.
- 10.08 All names must be printed in ink below the signatures.
- 10.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.
- 10.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be indicated on the Bid Form.
- 10.11 The Bid must contain evidence of Bidder’s authority to do business in the state where the Project is located. Bidder’s State of Washington Contractors License Number shall also be shown on the Bid Form.

ARTICLE 11—BASIS OF BID

11.01 *Lump Sum*

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

ARTICLE 12—SUBMITTAL OF BID

- 12.01 The Bidding Documents include one separate, unbound copy of the Bid Form, and, where required, the Bid Bond Form and other supplements to the Bid Form. The unbound copy

of the Bid Form and supplements (if any) are to be completed and submitted. See Section 00 41 13 – Bid Form for Bidders Checklist.

- 12.02 A Bid must be received no later than the date and time prescribed and at the place indicated in the Advertisement and must be enclosed in a sealed envelope, addressed to the Nisqually Tribe Center at 48920 She Nah Num Drive S.E., Olympia, WA 98513. Each sealed envelope containing a Bid must be plainly marked on the outside as Bid for Kalama Creek Hatchery Rebuild and the envelope should bear on the outside the Bidder's Name, address, and license number if applicable, and the name of the project for which the Bid is submitted. If forwarded by mail, the sealed envelope containing the Bid must be enclosed in another envelope addressed to the TRIBE at Nisqually Tribe 4820 Nah Num Drive S.E., Olympia, WA 98513. The Bid must be accompanied by the Bid security and other required documents.
- 12.03 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. Tribe accepts no responsibility for delays in returning Bids submitted or delivered to the incorrect location.

ARTICLE 13—MODIFICATION AND WITHDRAWAL OF BID

- 13.01 An unopened Bid may be withdrawn by an appropriate document duly signed in the same manner that a Bid must be signed and delivered to the place where Bids are to be submitted, prior to the date and time established in the Bidding Documents for the receipt of Bids or authorized postponement thereof. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.
- 13.02 If, within 24 hours after Bids are opened, any Bidder files a duly signed, written notice with Tribe and promptly thereafter demonstrates to the reasonable satisfaction of Tribe 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.
- 13.03 After the 24 hour period has expired indicated in Paragraph 15.03 of this Article, no Bidder may withdraw a Bid within 60 days after the actual date of the opening thereof. Should there be reasons why the Contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the Tribe and the Bidder.

ARTICLE 14—OPENING OF BIDS

- 14.01 Bids will be opened at the time and place indicated in the Advertisement and, unless obviously non-responsive, will be read aloud publicly live at the web address provided in

the Advertisement. 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 15—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 16—EVALUATION OF BIDS AND AWARD OF CONTRACT

- 16.01 Tribe may waive any informalities or minor defects and reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Tribe also reserves the right to waive all minor Bid informalities not involving price, time, or changes in the Work.
- 16.02 Tribe will reject the Bid of any Bidder that Tribe finds, after reasonable inquiry and evaluation, to not be responsible. Tribe may reject the Bid of any Bidder that fails to demonstrate appropriate qualifications, experience, and resources for the Work, in accordance with Article 3 of these Instructions to Bidders.
- 16.03 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 Tribe or Engineer, then Tribe will reject the Bid as nonresponsive.
- 16.04 *Basis for Award of Contract*
- A. Award will be made to the lowest responsive, responsible Bidder or all bids will be rejected.
 - B. In evaluating Bids, Tribe 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 elsewhere in the Bidding Documents, or prior to the Notice of Award.
 - C. In evaluating whether a Bidder is responsible, Tribe will consider the qualifications, experience, and resources of the Bidder and may consider the qualifications, experience, and resources 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.
 - D. Tribe, with or without Engineer's assistance, may conduct such investigations as Tribe deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

ARTICLE 17—BONDS AND INSURANCE

- 17.01 Paragraph 2.01 and Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, set forth Tribe's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder

delivers the signed Agreement to Tribe (or Tribe's representative), it must be accompanied by required bonds and insurance documentation.

- 17.02 A Performance Bond in the amount of 100 percent of the Contract Price, with a corporate Surety approved by the Tribe, will be required for the faithful performance of the Contract.
- 17.03 The party to whom the Contract is awarded will be required to execute the Agreement and obtain the Performance Bond within ten (10) working days from the date when Notice of Award is delivered to the Bidder. The Notice of Award shall be accompanied by the necessary Agreement and Bond forms. In case of failure of the Bidder to execute the Agreement, the Tribe may consider the Bidder in default, in which case the Bid Bond accompanying the proposal shall become the property of the Tribe.
- 17.04 Attorneys-in-fact who sign Bid Bonds or Performance Bonds must file with each Bond a certified and effective dated copy of their Power of Attorney.
- 17.05 Article 8 ("Bid Security") of these Instructions to Bidders addresses any requirements for providing bid bonds as part of the bidding process.

ARTICLE 18—SIGNING OF AGREEMENT

- 18.01 When Tribe issues a Notice of Award to the Successful Bidder, it will be accompanied by the unsigned 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 required bonds and insurance documentation (as required by the Contract Documents) to Tribe. Within 10 days thereafter, Tribe will deliver one fully signed 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 19—SALES AND USE TAXES

- 19.01 Tribe is exempt from Washington state sales tax, local sales tax, and use taxes on materials and equipment to be incorporated in the Work. Said taxes must be included in the Bid Form in line shown.

ARTICLE 20—CONTRACT START TIME & CONTACT INFORMATION

- 20.01 Contract time for this project is anticipated to begin by **07-01-2023**.
- 20.02 *The ENGINEER is HDR Engineering, Inc. represented by Eric Orton, PE (HDR) at 253-432-5042 or Eric.Orton@hdrinc.com .*

BID FORM

FOR CONSTRUCTION CONTRACT

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.

ARTICLE 1—BIDDERS CHECKLIST

1.01 The bidder's attention is especially called to the following forms, which must be executed, as required, and submitted on the form purchased from the Tribe and bound in the Contract Documents:

A. **BID FORM**

1. The bid prices, extensions and total amounts bid must be shown in the spaces provided.
2. Bidder shall fill in dates under Article 5 – Time of Completion
3. Acknowledge of Receipt of Addenda shall be filled in under Article 6 – Bidder's Acknowledgements: Acceptance Period, Instructions, and receipt of Addenda.

B. **BID BOND ACCOMPANYING BID**

1. This Bid Bond form is to be executed by the bidder and the surety company unless bid is accompanied by a certified check, cashier's check or cash. The amount shall be not less than 5% of the total amount bid and may be shown in dollars or on a percentage basis.

C. **PROPOSED MAJOR EQUIPMENT FORM**

D. **RESPONSIBLE BIDDER CRITERIA**

E. **BIDDER'S CERTIFICATION**

F. **PROPOSAL SIGNATURE SHEET**

1.02 The following forms must be received prior to the Contract being executed:

A. **AGREEMENT**

1. This agreement is to be executed by the successful bidder.

B. **PERFORMANCE BOND**

1. To be executed by the successful bidder and his/her Surety Company.

C. **PAYMENT BOND**

1. To be executed by the successful bidder and his/her Surety Company.

D. **CERTIFICATE OF INSURANCE**

1. Refer to 00 45 13 – Responsible Bidder Criteria for Sample Certificate of Insurance and Additional Insured Endorsement.

ARTICLE 2—OWNER AND BIDDER

- 2.01 This Bid is submitted to: Nisqually Tribal Center, 4820 She Nah Num Drive S.E., Olympia, WA 98513
- 2.02 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 3—ATTACHMENTS TO THIS BID

- 3.01 The following Bid Form provides an outline of the complete bid package. Referenced documents are to be inserted into the body of the Bid Form as a stand-alone complete package.

ARTICLE 4—BASIS OF BID—LUMP SUM BID

- 4.01 *Proposal*
 - A. To the Tribal Clerk of the Nisqually Indian Tribe, this certifies that the undersigned has examined the location of: Nisqually Indian Tribe's The Kalama Creek Hatchery Rebuild and other work, all to be constructed in accordance with the Plans and Specifications as prepared by the Nisqually Indian Tribe and contract governing the work embraced in this improvement, and the method by which payment will be made for said work, is understood. The undersigned hereby proposes to undertake and complete the work embraced in this improvement, or as much thereof as can be completed with the money available in accordance with the said plans, specifications and contract, and the following schedule of rates and prices.

NOTE: Bid prices for all items, all extensions, and total amount of bid, shall be shown, and be written in ink or typed. Show bid prices and total amounts. Figures written to the right of the dot (decimal) in the dollars column shall be considered as cents.

PROPOSAL BID SHEET

Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price(s).

PHASE 2

ITEM NO.	ITEM DESCRIPTION	UNIT	BID PRICE
1	MOBILIZATION	LS	
	All materials, labor, and equipment to accomplish the requirements set forth in Section 01 71 14 Mobilization and Demobilization including but not limited to the following: • Bonds and insurance • Licenses, insurance, and permits • Initial work schedule • Preconstruction meetings and conferences • Access planning and improvements • Establishing temporary power and facilities • Establish staging, parking, and storage areas and facilities • Movement of major equipment and vehicles to and from the site • Providing sanitary facilities • Disassembly, removal, and clean-up of temporary facilities • Final site clean-up • Final close-out		
2	GENERAL REQUIREMENTS	LS	
	All materials, labor, and equipment to accomplish the requirements set forth in Division 01 specification sections not listed elsewhere including: • Meeting attendance • Coordination with utilities • Coordination with resource agencies • Schedule maintenance and schedule submittals • Major submittals such as care of water, traffic control, and product delivery and storage • Compliance with environmental, permitting, and archeological requirements • Stormwater pollution prevention • Compliance with approved traffic control plan • Quality control and assurance • Start-up testing and commissioning • Operation and maintenance manuals • Record drawings		
3	DEMOLITION	LS	

ITEM NO.	ITEM DESCRIPTION	UNIT	BID PRICE
	All materials, labor, and equipment to accomplish the requirements set forth in Specification Section 01 41 00 and Plans 01D01 through 01D06 including but not limited to: • Demolition planning and submittals • Compliance with air and water quality requirements • Coordinating removals or revisions with utilities • All work associated with removing, transporting, and disposing of materials in accordance with applicable laws and regulations.		
4	SITEWORK	LS	
	All materials, labor, and equipment to accomplish the following work in accordance with the plans and specifications: • Miscellaneous excavation and backfill • Maintenance of access infrastructure such as ramps, roads, and gates • Maintenance and refinement of staging, storage, and material handling areas established as part of mobilization • Clearing and grubbing of trees and brush r • Installation, maintenance, and revision of temporary erosion control measures • Installation of fencing and gates • Drainage/stormwater improvements including piping and precast elements • Finished grading • Installing final surfaces including crushed aggregates, asphalt, etc. • Soil prep, topsoiling, seeding, and landscaping • Redistribution of salvaged trees and woody material • Revegetation		
5	CONSTRUCTION	LS	
	All materials, labor, equipment, and specialty trades required to construct a fully functioning concrete Lower Site Hatchery Renovation in accordance with the plans and specifications including but not limited to: • Excavations and backfills • Fill removal, haul, and disposal • Foundation preparation • Concrete structures • Concrete Pond Improvements • Predator Netting System • Intake Screen • Tensioned fabric structure and associated equipment • Mechanical systems, pumps, gates, valves, equipment, and piping • Electrical systems including generator, power, instrumentation, and controls systems		
		TOTAL	\$

DEDUCTIVE ALTERNATES

ITEM NO.	ITEM DESCRIPTION	UNIT	BID PRICE
01	CROWDERS	LS	
	All materials, labor, and equipment to accomplish the requirements set forth in Plans 04S403, and including but not limited to the following: • Concrete structures • Mechanical systems, filters, pumps, valves, equipment, and piping • Electrical systems including power, instrumentation, and controls systems		

ITEM NO.	ITEM DESCRIPTION	UNIT	BID PRICE
02	POLLUTION ABATEMENT POND	LS	
	All materials, labor, and equipment to accomplish the requirements set forth on plans 16S101, 16S401, 16D101, 16D401, 16D402, and 16E101 including but not limited to: • Concrete structures • Mechanical systems, filters, pumps, valves, equipment, and piping • Electrical systems including power, instrumentation, and controls systems		

ITEM NO.	ITEM DESCRIPTION	UNIT	BID PRICE
03	DEMOLITION OF EXISTING ADULT HANDLING SHED, CONCRETE MODS, AND NEW ADULT PEMB	LS	
	All materials, labor, equipment, and specialty trades required to demolish the existing adult handling shed and associated concrete, extend concrete surfacing, and erect new adult handling PEMB in accordance with the plans 02C102, 04C101, 04C103, 04E101, 04E401, 13A101 through 13E101, and specifications including but not limited to: • Excavations and backfills • Foundation preparation • Concrete structures, PEMP structure, and associated equipment • Mechanical systems, pumps, gates, valves, equipment, and piping • Electrical systems including power, instrumentation, and controls systems		

ARTICLE 5—TIME OF COMPLETION

- 5.01 Bidder agrees that the Work will be substantially complete on or before July 31, 2024. and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before August 30, 2024.

ARTICLE 6—BIDDER'S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

6.01 *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.

6.02 *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.

6.03 *Receipt of Addenda*

- A. Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 7—BID BOND

[ATTACH/INSERT FULLY EXECUTED BID BOND FORMS AFTER THIS PAGE]

ARTICLE 8—RESPONSIBLE BIDDER CRITERIA

- 8.01 Contractor must insert a fully complete Responsible Bidder Criteria as defined in Section 00 45 13 including the following:
- A. Evidence of authority to do business in Washington State; or a written covenant to obtain such authority within the time for acceptance of Bids;
 - B. Contractor's license number as evidence of Bidder's State Contractor's License or a covenant by Bidder to obtain said license within the time for acceptance of Bids;
 - C. Adoption of the Tribe's Non-Discrimination Provision and Women and Minority Business Enterprise Policy;
 - D. Contractor's information regarding Business's safety organization and safety performance;
 - E. Bid Surety
 - F. Responsible Bidder Criteria with supporting data.
 - G. A thorough summary of the Bidders Construction Experience with projects of similar scope and complexity.

[INSERT THE REQUIRED CONTENTS OF SECTION 00 45 13 RESPONSIBLE BIDDER CRITERIA AFTER THIS PAGE]

ARTICLE 9—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

9.01 *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 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.

9.02 *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.

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)

Bidder's Address for giving notices:

Bidder's Contact Person:

Name:

(typed or printed)

Title:

(typed or printed)

Phone:

Email:

Address:

Bidder's Contractor License No.: (if applicable)

BID BOND

Herewith find deposit in the form of a certified check, cashier's check, or cash in the amount of \$_____ which amount is not less than five percent of the total bid.

Sign Here _____

BID BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, _____, as principal, and _____, as Surety, are held and firmly bound unto the Nisqually Indian Tribe, as Obligee, in the penal sum of _____ Dollars, for the payment of which the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by these presents.

The condition of this obligation is such that if the Obligee shall make any award to the Principal for _____, according to the terms of the proposal or bid made by the Principal therefor, and the Principal shall duly make and enter into a contract with the Obligee in accordance with the terms of said proposal or bid and award and shall give bond for the faithful performance thereof, with Surety or Sureties approved by the Obligee; or if the Principal shall, in case of failure so to do, pay and forfeit to the Obligee the penal amount of the deposit specified in the call for bids, then this obligation shall be null and void; otherwise it shall be and remain in full force and effect and the Surety shall forthwith pay and forfeit to the Obligee, as penalty, the amount of this bond.

SIGNED, SEALED AND DATED THIS _____ DAY OF _____, 20_____

Principal

Surety

Received return of deposit in the sum of \$ _____

PROPOSAL SIGNATURE SHEET

KALAMA CREEK HATCHERY REBUILD
Nisqually Indian Tribe Project No. iC2010

The bidder is hereby advised that by signature of this proposal he/she is deemed to have acknowledged all requirements and signed all certificates contained herein.

A proposal guaranty in an amount of five percent (5%) of the total bid, based upon the approximate estimate of quantities at the above prices and in the form as indicated below, is attached hereto:

CASH ☐ IN THE AMOUNT OF _____

CASHIER'S CHECK ☐ _____ DOLLARS

CERTIFIED CHECK ☐ (\$ _____) PAYABLE TO THE TRIBE'S TREASURER

PROPOSAL BOND ☐ IN THE AMOUNT OF 5% OF THE BID

** Receipt is hereby acknowledged of addendum(s) No.(s) _____, _____ & _____

SIGNATURE OF AUTHORIZED OFFICIAL(s)

PROPOSAL MUST BE SIGNED

FIRM NAME _____

(ADDRESS) _____

PHONE NUMBER _____

STATE OF WASHINGTON CONTRACTORS LICENSE NUMBER _____

FEDERAL ID No.

WA STATE EMPLOYMENT SECURITY REFERENCE NO. _____

Note:

- (1) This proposal form is not transferable and any alteration of the firm's name entered hereon without prior permission from the Secretary of Transportation will be cause for considering the proposal irregular and subsequent rejection of the bid.
- (2) Should it be necessary to modify this proposal either in writing or by electronic means, please make reference to the following proposal number in your communication.

1. Failure to return this Declaration as part of the bid proposal package will make the bid nonresponsive and ineligible for award.
2. Non-Collusion Declaration
 - 2.1. I, by signing the proposal, hereby declare, under penalty of perjury under the laws of the United States that the following statements are true and correct:
 - 2.1.1. That the aforesigned person(s), firm, association or corporation has (have) not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the project for which this proposal is submitted.
 - 2.1.2. That by signing the signature page of this proposal, I am deemed to have signed and have agreed to the provisions of this declaration.
3. To report bid rigging activities call: 1 -800-424-9071
 - 3.1. The U.S. Department of Transportation (USDOT) operates the above toll-free “hotline” Monday through Friday, 8:00 a.m. to 5:00 p.m., Eastern time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the “hotline” to report such activities.
 - 3.2. The “hotline” is part of USDOT’s continuing effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the USDOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.
4. 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.
5. 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.
6. This obligation will be null and void if:
 - 6.1. 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
 - 6.2. All Bids are rejected by Owner, or
 - 6.3. 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 8 hereof).
7. 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.

8. 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.
9. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 7 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
10. 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.
11. 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.
12. 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.
13. 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.
14. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

RESPONSIBLE BIDDER CRITERIA

ARTICLE 1—GENERAL INFORMATION

1.01 Provide contact information for the Business:

Legal Name of Business:			
Corporate Office			
Name:		Phone number:	
Title:		Email address:	
Business address of corporate office:			
Local Office			
Name:		Phone number:	
Title:		Email address:	
Business address of local office:			

ARTICLE 2—LICENSING

2.01 Provide information regarding licensure for Business:

Name of License:			
Licensing Agency:			
License No:		Expiration Date:	
Name of License:			
Licensing Agency:			
License No:		Expiration Date:	

ARTICLE 3—DIVERSE BUSINESS CERTIFICATIONS

3.01 Non-Discrimination Provision

A. During the performance of this contract, the contractor agrees as follows:

1. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and

applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.
3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under Section 202 of Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. The contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
5. The contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any such rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies involved as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.
7. The contractor will include the provisions of Paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions including sanctions for noncompliance:
 - a. Provided however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the contractor may request the United States to enter into such litigation to protect the interests of the United States."

3.02 Women and Minority Business Enterprise Policy

- A. It is the policy of the Nisqually Indian Tribe that women and minority business enterprises shall have the maximum opportunity to participate in the performance of work relating to the Tribe's activities. To this end, the Tribe is committed to take all necessary and reasonable steps in accordance with state and federal rules and regulations to ensure women and minority business enterprises the maximum opportunity to compete for and to perform contracts.
- B. In order to enhance opportunities for women and minority businesses to participate in certain contractor opportunities with the Tribe, and as a recipient of federal and state financial assistance, the Tribe is committed to a women and minority business enterprise utilization program. The Tribe is determined to maximize women and minority business opportunities through participation in the competitive bidding process through women and minority business enterprise affirmative action programs administratively established by the Tribe and monitored and implemented in accordance with Tribal rules and regulations. All

women and minority business enterprise programs shall include specific goals for participation of women and minority businesses in Tribal projects of at least ten percent (10%) of the total dollar value of Tribe's contract over \$10,000. Goals shall be reviewed and updated annually by the Tribe for applicability and to ensure that the intent of this policy is accomplished.

- C. This statement of policy will be widely disseminated to all managers, supervisors, minorities and women employed by the Tribe as well as to contractors, vendors, suppliers, minorities and women who may seek the Tribe's procurement and construction contracts related to the women and minority business enterprise programs. Contractors' associations will be made aware of construction projects affected by this policy through all available avenues to assure that plans/specifications, bid forms, and invitations to bid are as widely distributed as possible.

3.03 Affirmative Action Plan

- A. The bidders, contractors and subcontractors will not be eligible for award of a contract under this Advertisement for Bids unless it certifies as prescribed, that it adopts the minimum goals and timetable of minority and women workforce utilization and specific affirmative action steps as set forth by the Tribe. This is directed at increasing minority and women workforce utilization by means of applying good faith efforts to carrying out such steps.
- B. However, no contractor or subcontractor shall be found to be in noncompliance solely on account of its failure to meet its goals within its timetables, but such contractor shall be given the opportunity to demonstrate that it has instituted all of the specific affirmative action steps specified by the Tribe, and has made every good faith effort to make these steps work toward the attainment of its goals, all to the purpose of expanding minority and women workforce utilization on all of its projects in the Nation of the Nisqually Tribe. In all cases, the compliance of a bidder, contractor or subcontractor will be determined in accordance with its respective obligations under the terms of these Bid Conditions.
- C. All bidders and all contractors and subcontractors performing or to perform work on projects subject to these Bid Conditions hereby agree to inform their subcontractors of their respective obligations under the terms and requirements of these Bid Conditions, including the provisions relating to goals of minority and women employment and training.
- D. Specific Affirmative Action Steps
 - 1. Bidders, contractors and subcontractors subject to this contract must engage in affirmative action directed at increasing minority and women workforce utilization, which is at least as extensive and as specific as the following steps:
 - a. The contractor shall notify community organizations that the contractor has employment opportunities available and shall maintain records of the organizations' response.
 - b. The contractor shall maintain a file of the names and addresses of each minority and women worker referred to him and what action was taken with respect to each such referred worker, and if the worker was not employed, the reasons therefore. If such worker was not sent to the union hiring hall for referral or if such worker was not employed by the contractor, the contractor's file shall document this and the reasons therefore.
 - c. The contractor shall promptly notify the Tribe Engineering Representative and Contract Compliance Officer when the union or unions with whom the contractor has collective bargaining agreement has not referred to the contractor a minority or woman worker sent by the contractor or the contractor has other information that the union referral process has impeded him in his efforts to meet his goal.
 - d. The contractor shall participate in training programs in the area, especially those funded by the Department of Labor.

- e. The contractor shall disseminate his EEO policy within his own organization by including it in any policy manual; by publicizing it in company newspapers, annual reports, etc., by conducting staff, employee and union representatives' meetings to explain and discuss the policy; by posting of the policy; and by specific review of the policy with minority employees.
- f. The contractor shall disseminate his EEO policy externally by informing and discussing it with all recruitment sources; by advertising in news media, specifically including minority news media; and by notifying and discussing it with all subcontractors and suppliers.
- g. The contractor shall make specific efforts and constant personal (both written and oral) recruitment efforts directed at all minority or women organizations, schools with minority students, minority recruitment organizations and minority training organizations, within the contractor's recruitment areas.
- h. The contractor shall make specific efforts to encourage present minority employees to recruit their friends and relatives.
- i. The contractor shall validate all main specifications, selection requirements, tests, etc.
- j. The contractor shall make every effort to promote after school, summer and vacation employment to minority youth.
- k. The contractor shall develop on-the-job training opportunities and participate and assist in any association or employer group training programs relevant to the contractor's employee needs consistent with its obligations under this bid.
- l. The contractor shall continually inventory and evaluate all minority and women personnel for promotion opportunities and encourage minority and women employees to seek such opportunities.
- m. The contractor shall make sure that seniority practices, job classifications, etc., do not have a discriminatory effect.
- n. The contractor shall make certain that all facilities and company activities are non-segregated.
- o. The contractor shall continually monitor all personnel activities to ensure that his EEO policy is being carried out.
- p. The contractor shall solicit bids for subcontracts from available minority and women subcontractors, engaged in the trades covered by these Bid Conditions, including circulation of minority and women contractor associations.
- q. Non-cooperation: In the event the union is unable to provide the contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreements, the contractor shall, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex or national origin, making full efforts to obtain qualified and/or qualifiable minorities and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority or women employees.) In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246 and 23 CFR Part 230 as amended, such contractor shall immediately notify the Tribe's Engineering Representative or the Tribe Compliance Officer.

3.04 Bidder Certification

A bidder will not be eligible for award of a contract under the Advertisement for Bids unless such bidder has submitted as a part of its bid the following certification, which will be deemed a part of the resulting contract:

_____ certifies that:
(BIDDER)

1. Intends to use the following listed construction trades in the work under the contract

_____ and;

as to those trades for which it is required by these Bid Conditions to comply with these Bid Conditions, it adopts the minimum minority and women workforce utilization goals and the specific affirmative action steps for all construction work (both federal and non-federal) in the Nation of Nisqually, Washington area subject to these Bid Conditions, those trades being:

_____ and;

2. It will obtain from each of its subcontractors and submit to the contracting or administering agency prior to the award of any sub-contract under this contract the Subcontractor Certification required by these Bid Conditions.

(Signature of Authorized Representative of Bidder)

3.05 SUBCONTRACTOR CERTIFICATION

Subcontractors' Certification is not required at the time of bid. This Certification must be completed by each subcontractor prior to award of any subcontract.

_____ certifies that:
(SUBCONTRACTOR)

1. It intends to use the following listed construction trades in the work under the subcontract

_____ and;

As to those trades for which it is required by these Bid Conditions to comply with these Bid Conditions, it adopts the minimum minority and women workforce utilization goals and the specific affirmative action steps for all construction work (both federal and non-federal) in Nation of Nisqually, Washington, subject to these Bid Condition, those trades being:

_____ and;

2. It will obtain from each of its subcontractors prior to the award of any subcontract under this subcontract the Subcontractor Certification required by these Bid conditions.

(Signature of Authorized Representative of Subcontractor)

ARTICLE 4—SAFETY

- 4.01 Provide information regarding Business's safety organization and safety performance.

Name of Business's Safety Officer:		
Safety Certifications		
Certification Name	Issuing Agency	Expiration

- 4.02 Provide Worker's Compensation Insurance Experience Modification Rate (EMR), Total Recordable Frequency Rate (TRFR) for incidents, and Total Number of Recorded Manhours (MH) for the last 3 years and the EMR, TRFR, and MH history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 10% or more of the Contract Price. Provide documentation of the EMR history for Business and Subcontractor(s).

Year									
Company	EMR	TRFR	MH	EMR	TRFR	MH	EMR	TRFR	MH

ARTICLE 5—FINANCIAL

- 5.01 Section not used.

ARTICLE 6—SURETY INFORMATION

- 6.01 Provide information regarding the surety company that will issue required bonds on behalf of the Business, including but not limited to performance and payment bonds.

Surety Name:			
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location?	☐ Yes ☐ No		
Is surety listed in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" published in Department Circular 570 (as amended) by the Bureau of the Fiscal Service, U.S. Department of the Treasury?			
☐ Yes ☐ No			
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 7—CERTIFICATE OF INSURANCE

7.01 Contractor shall provide Informational Certificate of Insurance and Additional Insured Endorsement.

ARTICLE 8—CONSTRUCTION EXPERIENCE

8.01 Prospective Bidders must submit with their Bid required information in a narrative format regarding their qualifications and experience with previous successfully completed projects. Owner will review the submitted information to determine which contractors meet the minimum qualification requirements. Bids will only be accepted from registered contractors meeting the minimum qualification requirements. The information that each prospective Bidder must submit to meet minimum qualification requirements includes the following:

- A. The Contractor or subcontractor performing in-water work shall have successfully completed at least three (3) projects that include construction of river bypasses, specialized equipment such as fish screens and water control gates, and in-river concrete structures such as surface-water intakes. At least one of the three projects presented must demonstrate that these features contributed to \$1M or more in the overall project construction cost within (10) years of the bid submittal date.
- B. The Contractor or subcontractor performing in-water work shall have successfully completed at least three (3) projects that include rock profile control structures and rock slope protection within rivers. At least one of the three projects must demonstrate that these features contributed to \$1M or more in the overall project construction cost within (10) years of the bid submittal date.
- C. As part of the qualification's summary, Bidder shall demonstrate that they satisfy the following project elements:
 - 1. Compliance with the following Federal and State permit approvals and applicable project environmental permit conditions:
 - a. Clean Water Act Section 401 (water quality certification), 402 (NPDES construction stormwater discharge) and 404 (fill discharge authorization),
 - b. Endangered Species Act, including fish exclusion, capture and release of ESA-listed species during project implementation.
 - c. State of Washington Dept. of Fish and Wildlife Hydraulic Project Approval, or equivalent/similar permit approval from the regulatory agency of the state where the completed project is located.
 - 2. Experience with the kind of work to be performed, including:
 - a. In-water construction work involving the design and implementation of a work zone isolation, river bypass, and dewatering system within an alluvial river. Experience must demonstrate how sequencing and multiple phases of in-water work were required to accomplish project construction.
 - b. Procurement, fabrication, and installation of complex in-water elements such as fish protection screens, fish passage systems, and accompanying mechanical and electrical systems.
 - c. Rock sourcing, installation, and equipment requirements for large diameter (36-inch and greater) boulder structures.
 - d. Excavation, staging, sorting, mixing, and installation of rock gradations composed of on-site materials.
 - e. Knowledge of methods and constraints to install materials into in-river situations in conformance with compaction and seepage requirements.

- 8.02 Bidders shall be experienced in the kind of Work to be performed, shall have the or be able to obtain construction equipment necessary for the Work, and shall possess sufficient capital to properly perform the Work within the time allowed. Bids received from Bidders who have previously failed to complete work within the time required, or who have previously performed similar work in an unsatisfactory manner, may be rejected. A Bid may be rejected if Bidder cannot show and document to Owner's satisfaction that Bidder has the necessary ability, facilities, equipment, and resources to commence the Work at the time prescribed and thereafter to prosecute and complete the Work at the rate or within the times specified. A Bid may be rejected if Bidder is already obligated for the performance of other work which would delay the commencement, prosecution or completion of the Work.

ARTICLE 9—REQUIRED ATTACHMENTS

- 9.01 Provide the following information with the Responsible Bidder Criteria:
- A. If Business is a Women and Minority Business Enterprise per Resolution D-4816 (attached), include specific goals as required in Paragraph 3.02.
 - B. Certificate of Insurance and Additional Insured Endorsement (samples attached) required by Paragraph 7.01.

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AGREEMENT

THIS AGREEMENT, made and entered into in triplicate, this ____ day of _____, 20____, by and between the Nisqually Indian Owner, hereinafter called the Owner, and _____ a _____ Corporation, hereinafter called the Contractor.

WITNESSETH:

That in consideration of the terms and conditions contained herein and attached and made a part of this agreement, the parties hereto covenant and agree as follows:

I. The Contractor shall do all work and furnish all tools, materials, labor and equipment for THE BID AMOUNT OF: \$_____, for **Kalama Creek Hatchery Rebuild**, all in accordance with, and as described in the attached plans and specifications which are by this reference incorporated herein and made a part hereof, and shall perform any alterations in or additions to the work provided under this contract and every part thereof.

Work shall start within **ten (10)** days after the Notice to Proceed and shall be completed on or before June 1, 2024. If work has not commenced within the ten (10) days after the Notice to Proceed, the first chargeable working day shall be the 11th day after the date on which the Owner issues the Notice to Proceed.

The Contractors shall provide and bear the expense of all equipment, work and labor of any sort whatsoever that may be required for the transfer of materials and for constructing and completing the work provided for in this contract and every part thereof, except such as are mentioned in the specifications to be furnished by the Owner.

II. The Owner hereby promises and agrees with the Contractor to employ, and does employ the Contractor to provide the materials and to do and cause to be done the above described work and to complete and finish the same according to the attached plans and specifications and the terms and conditions herein contained and hereby contracts to pay for the same according to the attached specifications and the schedule of unit or itemized prices hereto attached, at the time and in the manner and upon the conditions provided for in this contract.

III. INDEMNIFICATION. The Contractor shall defend, indemnify, and hold harmless the Tribe, its officers, elected officials, employees, agents, and Engineer from and against any and all claims, causes of action, damages, losses, and expenses of any kind or nature whatsoever, including but not limited to, attorney's fees and court costs, arising out of, relating to, or resulting from the Contractor's performance or non-performance of the services, duties and obligations required of it under this Agreement.

IV. The Contractor for himself, and for his heirs, executors, administrators, successors, and assigns, does hereby agree to the full performance of all the covenants herein contained upon the part of the Contractor.

V. It is further provided that no liability shall attach to the Owner by reason of entering into this contract, except as expressly provided herein.

IN WITNESS WHEREOF the parties hereto have caused this agreement to be executed the day and year first herein above written.

ARTICLE 1—WORK

- 1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described in Specification 01 10 00.

ARTICLE 2—THE PROJECT

- 2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: Kalama Creek Hatchery Rebuild.

ARTICLE 3—ENGINEER

- 3.01 The part of the Project that pertains to the Work has been designed by:

HDR Engineering, Inc.
4717 97th St,
Gig Harbor, WA 98332

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: Dates*

- A. See Request for Proposal (RFP) for contract dates.

- 4.06 *Special Damages*

- A. Contractor shall reimburse Owner (1) for fines and penalties (if any) imposed on Owner as a direct result of Contractor's failure to attain Substantial Completion according to the Contract Times, (2) for fines and penalties (if any) imposed on Owner by an authority having jurisdiction for actions or inaction of Contractor arising from Contractor's performance of the Work (regardless of whether such event was connected with any delay in compliance with the Contract Times), and (3) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.
- B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.

- 4.07 Owner reserves the right to withhold from payments due Contractor under the Contract amounts for special damages (if any) and performance damages (if any) in accordance with the Contract.

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, a lump sum of \$_____.

All specific cash allowances are included in the above price in accordance with Paragraph 13.02 of the General Conditions.

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 20th 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, 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.

6.05 *Interest*

- A. All amounts not paid when due will bear interest at the maximum rate allowed by law at the place of the Project.

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.
 - 6. Drawings (not attached but incorporated by reference) consisting of sheets bearing the following general title: Kalama Creek Hatchery Rebuild.
 - 7. Drawings.
 - 8. Addenda (Refer to 00 41 13 – Bid Form)).
 - 9. Exhibits to this Agreement (enumerated as follows):
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - 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.
 - f. Change Proposal Request.

- 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.

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. Not Used.
 - 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.

Owner:

(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:

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

Phone: _____

Email: _____

(If [Type of Entity] is a corporation, attach evidence of authority to sign. If [Type of Entity] is a public body, 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 Contractor 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: _____

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PERFORMANCE BOND

BOND TO NISQUALLY INDIAN TRIBE

KNOW ALL MEN BY THESE PRESENTS:

That whereas the Nisqually Indian Tribe (Tribe), Washington has awarded to _____ (Contractor) hereinafter designated as the "Principal" a contract for the construction of the project designated **Kalama Creek Hatchery Rebuild**, all as hereto attached and made a part hereof and whereas, said principal is required under the terms of said contract to furnish a bond for the faithful performance of said contract:

NOW, THEREFORE, we, the principal, and _____, a corporation, organized and existing under and by virtue of the laws of the State of _____, duly authorized to do business in the State of Washington, as surety, are jointly and severally held and firmly bound unto the Tribe, Washington, in the penal sum of \$ _____ (Total Contract Amount) lawful money of the United States, the payment of which we jointly and severally bind ourselves, our heirs, executors, administrators and assigns, and successors and assigns, firmly by these presents.

THE CONDITIONS OF THIS BOND IS SUCH, that if the above bonded principal shall faithfully perform all of the provisions of said contract in the manner and within the time therein set forth, or within such extensions of time as may be granted under said contract, and shall pay all laborers, mechanics, sub-contractors and materialmen; the claims of any person or persons arising under the contract to the extent such claims are provided for in RCW 39.08.010; the state with respect to taxes imposed pursuant to Titles 50, 51 and 82 RCW which may be due; and all persons who shall supply said principal or sub-contractors with provisions and supplies for the carrying on of said work, and shall hold said Tribe, Washington, their employees, agents, and elected or appointed officials, harmless from any damage occasioned to any person or property by reason of any carelessness or negligence on the part of said principal, or any sub-contractor in the performance of said work, and shall indemnify and hold the Tribe, Washington, its employees, agents, and elected or appointed officials, harmless from any damage or expense by reason of failure of performance as specified in said contract, or from defects appearing or developing in the material or workmanship provided or performed under said contract after its acceptance thereof by the Tribe, Washington, and all claims filed in compliance with Chapter 39.08 RCW are resolved and all taxes pursuant to Titles 50 and 51 and 82 RCW have been paid, then and in that event this obligation shall be void; but otherwise it shall be and remain in full force and effect.

This obligation is entered into in pursuance of the statutes of the State of Washington, and the Ordinances of the Tribe.

IN WITNESS WHEREOF, the said principal and the said surety have caused this bond to be signed and sealed by their duly authorized officers this

_____ day of _____, 202__.

(Principal)

By: _____
(Signature)

(Print Name)

Approved as to form:

(Title)

(Tribal Attorney)

(Surety)

By: _____
(Signature)

(Print Name)

1. Not Used.

2. 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.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
 - 3.1. 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;
 - 3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
 - 3.3. 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.
4. 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.
5. 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:
 - 5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
 - 5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
 - 5.3. 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
 - 5.4. 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.

6. 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.
7. 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:
 - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
 - 7.2. 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
 - 7.3. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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.

14. Definitions

- 14.1. *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.
 - 14.2. *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.
 - 14.3. *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.
 - 14.4. *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.
 - 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. 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.
16. Modifications to this Bond are as follows: None.

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PAYMENT BOND

Contractor Name: Address <i>(principal place of business)</i> :	Surety Name: Address <i>(principal place of business)</i> :
Owner Name: Nisqually Indian Tribe Mailing address <i>(principal place of business)</i> : 4820 She-Nah-Num Dr. SE Olympic, WA 98513	Contract Description <i>(name and location)</i> : Kalama Creek Hatchery Rebuild Contract Price: Effective Date of Contract:
Bond Bond Amount: Date of Bond: <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i> 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
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
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.

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, expeditors, 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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SUPPLEMENTARY CONDITIONS

OF THE CONSTRUCTION CONTRACT

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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, if any, used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

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

Article 1—DEFINITIONS AND TERMINOLOGY

SC-1.01.A.40 Add the following to Paragraph 1.01.A.40:

Trucking, shipping, delivery firms, consultants, and entities performing testing or inspection retained by Contractor or any Subcontractor are considered to be Subcontractors.

SC-1.01.A.45 Add the following to Paragraph 1.01.A.45:

Entities that rent construction equipment or machinery, but are not incorporated into the Work, are considered to be Suppliers. If such rental entity furnishes both equipment and one or more personnel to operate and maintain the equipment, such entity is a Subcontractor.

Article 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

SC-2.01 Delete Paragraphs 2.01.B. and C. in their entirety and insert the following in their place:

- B. *Evidence of Contractor's Insurance:* When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies (including all endorsements, and identification of applicable self-insured retentions and deductibles) of insurance required to be provided by Contractor in this Contract. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

2.02 *Copies of Documents*

SC-2.02 Amend the first sentence of Paragraph 2.02.A to read as follows:

Owner shall furnish to Contractor one copy in electronic portable document format (PDF).

Exhibit C—Geotechnical Baseline Report Supplement to the Supplementary Conditions.

EJCDC® C-800, Supplementary Conditions of the Construction Contract.

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Article 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

SC-3.01 Delete Paragraph 3.01.C in its entirety.

SC-3.01 Add the following new paragraphs immediately after Paragraph 3.01.E:

- F. The Specifications and other verbal components of the Contract Documents may vary in form, format, and style. Some Specification sections are written in varying degrees of streamlined or declarative style and some Specifications sections may, in comparison, employ a more-narrative style. Omissions of such words and phrases as "Contractor shall," "in conformity with," "as shown," or "as specified" are intentional in streamlined language in the Contract Documents. Omitted words and phrases are incorporated by inference. Similar types of provisions may appear in various parts of a Specifications section or elsewhere in the Contract Documents. Contractor shall not attempt to take advantage of any variation of form, format or style in Change Proposal(s) and Claim(s).
- G. Cross referencing of Specification sections in a Specifications section's heading "Related Sections includes, but are not necessarily limited to: "and elsewhere within each Specifications section is provided as an aid and convenience to Contractor. Contractor shall not rely on cross referencing indicated and is responsible for coordinating the entire Work and providing a complete Project whether or not cross referencing is provided in each Specifications section or whether or not cross referencing is complete.

Article 4—COMMENCEMENT AND PROGRESS OF THE WORK

No Supplementary Conditions in this Article.

Article 5—SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

5.03 *Subsurface and Physical Conditions*

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.D:

- 1. The following reports of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:
 - a. Geotechnical Data Report
 - a. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.
 - b. Record Drawings, Reference Drawings, and As-builts by others
 - c. Those drawings 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.

- d. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.
- e. Technical Data contained in such reports and drawings.

SC-5.04.A Add the following new paragraph immediately after Paragraph 5.04.A.4:

- 5. Contractor encounters human remains, recognizes the existence of burial markers, archaeological sites, historical sites, artifacts of potential archaeological or historical interest, or wetlands not shown or indicated in the Contract Documents, Contractor shall immediately cease operations that may disturb such area(s) and secure the adjacent Work; and Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations (Contractor shall continue to suspend such operations until otherwise instructed by Owner but shall continue with all other operations that do not affect those remains or features);

5.06 *Hazardous Environmental Conditions*

SC 5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

- A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.
- B. Not used.

Article 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.A:

- 1. *Required Performance Bond Form:* The performance bond that Contractor furnishes will be in the form of EJCDC® C-610, Performance Bond (2010, 2013, or 2018 edition).
- 2. *Required Payment Bond Form:* The payment bond that Contractor furnishes will be in the form of EJCDC® C-615, Payment Bond (2010, 2013, or 2018 edition).

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.B:

- 1. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be two years after Substantial Completion.

6.02 *Insurance—General Provisions*

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker's compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the Project is located, (b) is certified or authorized as a worker's compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker's compensation insurance for similar projects by the state within the last 12 months.

6.03 *Contractor's Insurance*

SC-6.03 Supplement Paragraph 6.03 with the following provisions after Paragraph 6.03.C:

- A. *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
Jones Act (if applicable)	
Bodily injury by accident—each accident	\$ 1,000,000
Bodily injury by disease—aggregate	\$ 1,000,000
Employer's Liability	
Each accident	\$ 1,000,000
Each employee	\$ 1,000,000
Policy limit	\$ 1,000,000
Stop-gap Liability Coverage	
For work performed in monopolistic states, stop-gap liability coverage must be endorsed to either the worker's compensation or commercial general liability policy with a minimum limit of:	\$ 1,000,000

- B. *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.
- C. *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.
- D. *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.

E. Commercial General Liability—Minimum Policy Limits

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

* The \$2,000,000 limits can be satisfied by the amounts listed above or combined with an umbrella policy covering the limit amount.

- F. 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	\$ 2,000,000*
Each Accident	\$ 2,000,000*
Property Damage	
Each Accident	\$ 2,000,000*
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	\$ 2,000,000*

* The \$2,000,000 limits can be satisfied by the amounts listed above or combined with an umbrella policy covering the limit amount.

- G. *Contractor's Pollution Liability Insurance:* Contractor shall purchase and maintain a policy covering third-party injury and property damage, including cleanup costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance must be maintained for no less than three years after final completion.

Contractor's Pollution Liability	Policy limits of not less than:
Each Occurrence/Claim	\$ 2,000,000
General Aggregate	\$ 2,000,000

- H. *Contractor's Professional Liability Insurance:* If Contractor will provide or furnish professional services under this *Contract*, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. The retroactive date on the policy must pre-date the commencement of furnishing services on the Project.

Contractor's Professional Liability	Policy limits of not less than:
Each Claim	\$ 2,000,000
Annual Aggregate	\$ 2,000,000

- I. *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, 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	\$ 1,000,000

6.04 *Builder's Risk and Other Property Insurance*

SC-6.04 Supplement Paragraph 6.04 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,

Exhibit C—Geotechnical Baseline Report Supplement to the Supplementary Conditions.

EJCDC® C-800, Supplementary Conditions of the Construction Contract.

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falsework, and materials and equipment stored and in transit, and must not exclude the coverage of the following risks: fire; windstorm; hail; flood; earthquake, volcanic activity, 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 \$16,000,000.
 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 \$16,000,000.
 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." In addition to Owner, Contractor, and Subcontractors of every tier, include as insureds the following:
 11. include, in addition to the Contract Price amount, the value of the following equipment and materials to be installed by the Contractor but furnished by the Owner or third parties: None.
 12. If debris removal in connection with repair or replacement of insured property is subject to a coverage sublimit, such sublimit will be a minimum of \$50,000.
 13. In addition to the coverage sublimits stated above, the following coverages are also subject to sublimits, as follows: _____
- G. *Coverage for Completion Delays:* The builder's risk policy will include, for the benefit of Owner, loss of revenue and soft cost coverage for losses arising from delays in completion that result from covered physical losses or damage. Such coverage will include, without limitation, fixed expenses and debt service for a minimum of 12 months with a maximum deductible of 30 days, compensation for loss of net revenues, rental costs, and attorneys' fees and engineering or other consultants' fees, if not otherwise covered.
- H. *Builder's Risk and Other Property Insurance Deductibles:* The purchaser of any required builder's risk, installation floater, or other property insurance will be responsible for costs not covered because of the application of a policy deductible.
1. The builder's risk policy will be subject to a deductible amount of not more than \$25,000 for direct physical loss in any one occurrence.

6.05 *Property Losses; Subrogation*

SC-6.05 Delete Paragraph 6.05.B.1 in its entirety.

Article 7—CONTRACTOR'S RESPONSIBILITIES

7.02 *Supervision and Superintendence*

SC-7.02 Add the following to Paragraph 7.02, following Paragraph 7.02.B:

- C. Unless Owner otherwise agrees in writing, the superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All

communications given to or received from the superintendent shall be binding on Contractor.

7.03 Labor; Working Hours

SC-7.03 Add the following new subparagraphs immediately after Paragraph 7.03.C:

1. Regular working hours will be 7:00 am to 6:00 pm.
2. Owner's legal holidays are New Years Day, Martin Luther King Day, Presidents Day, Memorial Day, July 4th, Labor Day, Veterans Day, Thanksgiving Day, Day after Thanksgiving, Christmas Day.

SC-7.03 Add the following new paragraph immediately after Paragraph 7.03.C:

- D. Contractor shall be responsible for the cost of overtime (premium) pay and other expense incurred by Owner for Engineer's services (including those of the Resident Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-7.03 Add the following new subparagraph immediately after Paragraph SC-7.03.D:

3. For purposes of administering the foregoing requirement, additional overtime costs are defined as Work outside Normal Working Hours which are as follows: Monday through Friday, 7:00 am to 3:30 pm.
4. For purposes of administering the foregoing requirement, Engineer's labor costs shall be determined based on the wage rates in the following table. Overtime wages are 1.5 times those listed for Normal Working Hours. Engineer's expenses for materials, equipment, supplies, transportation and subsistence shall be calculated as actual cost plus 10 percent mark-up.

<u>Engineering Resource</u>	<u>Normal Working Hours Rate</u>
Project Manager	\$ 240.00
Construction Manager	\$ 320.00
Project Engineer	\$ 144.00
Resident Project Representative	\$ 176.00
Software Integrator	\$ 132.00
CAD/BIM Technician	\$ 90.00
Clerical	\$ 60.00
Other	Actual rate

7.14 Hazard Communication Programs

SC-7.14 Add the following new paragraph immediately after Paragraph 7.14.A:

- B. *Single Prime Contract*: Contractor shall be responsible for coordinating exchange of 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 and Regulations. Contractor shall provide a centralized location for the maintenance of the safety data sheets or other hazard communication information required to be made available by any employer on the Site. Location of the material safety data sheets or other hazard communication information shall be readily accessible to the employees of employers on the Site.

Article 8—OTHER WORK AT THE SITE

No Supplementary Conditions in this Article.

Article 9—OWNER’S RESPONSIBILITIES

No Supplementary Conditions in this Article.

Article 10—ENGINEER’S STATUS DURING CONSTRUCTION

10.03 Resident Project Representative

SC-10.03 Add the following new subparagraph immediately after Paragraph 10.03.A:

1. On this Project, by agreement with Owner, the Engineer will not furnish a Resident Project Representative to represent Engineer at the Site or assist Engineer in observing the progress and quality of the Work. The Tribe will provide Resident Project Representatives to perform daily inspection and construction monitoring services.

Article 11—CHANGES TO THE CONTRACT

No Supplementary Conditions in this Article.

Article 12—CLAIMS

No Supplementary Conditions in this Article.

Article 13—COST OF WORK; ALLOWANCES, UNIT PRICE WORK

13.01 Cost of the Work

SC-13.01.B.5.c.(1) Supplement Paragraph 13.01.B.5.c.(1) by adding the following subparagraphs:

- a) Prior to commencing Work at the Site, submit to Owner, through Engineer, copies of the equipment rental agreements for Owner's approval.
- b) Should Contractor perform Work using rented construction equipment or machinery without Owner's written approval of the associated rental agreement and the parties subsequently disagree on the applicable rental rates, use of such construction equipment and machinery will be compensated on the basis of the rental rate book indicated in Paragraph SC-13.01.B.5.c.(2).
- c) When the rental rate book is used basis for determining compensation for construction equipment and machinery leased from a rental firm, the hourly rate for such equipment shall be determined in accordance with Paragraph 13.01.B.5.(2) of the General Conditions.

SC-13.01.B.5.c Supplement Paragraph 13.01.B.5.c by adding the following subparagraphs:

- 4) *Inactive Equipment and Machinery*: Rental of construction equipment and machinery shall cease when the use thereof is no longer necessary for the Work. Periods of inactivity for such construction equipment or machinery will not be compensable unless agreed upon in writing by Owner, unless the costs of disassembly, removal, transportation, reassembly, and remobilization, as submitted to and accepted by Owner (with advice of Engineer) would exceed the cost of continuing to rent the item(s) during the period(s) of inactivity. Contractor is responsible for obtaining Owner's written approval for compensation for construction equipment and machinery for periods of inactivity. Owner is not responsible for retroactively approving such inactivity. "Period of inactivity" for such items includes periods when the construction equipment or machinery is not used or necessary for the logical and efficient progression of the Work, or when other, available equipment or machinery is suitable for performing the given task.
- 5) *Condition of Equipment and Machinery*: Construction equipment and machinery will be compensable only for serviceable construction equipment and machinery capable of efficiently performing its intended function at the Site. Construction equipment and machinery not in compliance with this Paragraph SC-13.01.B.5.c.5) is not eligible for compensation.
- 6) *Capped Compensation*: Compensation paid Contractor for a given item of Contractor-owned construction equipment or machinery will be capped at, and shall not exceed, the comparable purchase price of such item of equal or comparable capacity and capability.

SC-13.01.C.2 Supplement Paragraph 13.01.C.2 by adding the following definition of small tools and hand tools:

- a. For purposes of this paragraph, "small tools and hand tools" means items in one or more of the following categories: (1) Items that are ordinarily required for the performing worker's job function, including but not limited

to equipment which ordinarily has no associated licensing, insurance, or substantive storage costs; such as hammers, wrenches, socket tools, manual saws, power saws, chainsaws, common power tools, impact drills, threaders, benders, transits and theodolites and related equipment, and other tools transportable by hand, regardless of ownership of such items; (2) Items such as gang-boxes, ladders, hand carts and similar wheeled items manually operated by workers, extension cords, and similar items; (3) common testing equipment such as insulation testers (megger-testing equipment), amp meters, gas detectors, pressure gauges, and similar items; (4) A purchase price (if purchased new, at retail) of \$500, although such limit is not absolute, and certain items may be deemed by Owner or Engineer as “small tools or hand tools” (and not eligible for compensation) even though such item may have a purchase price greater than the amount indicated in this Paragraph 13.01.C.2.

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

No Supplementary Conditions in this Article.

Article 15—PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

15.01 Progress Payments

SC-15.01 Modify Paragraph 15.01.D.1 by replacing the word, “Ten” with the word, “Thirty.”

15.02 Substantial Completion

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

1. If some or all of the Work has been determined by Engineer not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer or other entity retained by Owner, 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.

1.06 Final Payment

SC-15.06.E The last sentence of paragraph 15.06.E shall be removed and replaced with the following:

- A. Owner shall pay the resulting balance due to Contractor within 45 - 60 days of Owner’s receipt of the final Application for Payment from Engineer, provided that Contractor has met its statutory obligations, including providing Owner with Affidavits of Wages Paid (Contractor and sub-contractors).

1.07 *Waiver of Claims*

SC-15.07.B Remove paragraph 15.07.B in its entirety and replace it with the following:

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

15.08 *Correction Period*

SC-15.08.A Remove the first paragraph in its entirety and replace it with the following:

- A. If within two years 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.

SC-15.08.G Add the following new Paragraph 15.08.G:

- G. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be the number of years set forth in Paragraph SC-6.01.B.1; or if no such revision has been made in SC-6.01.B, then the correction period is hereby specified to be two years after the date of Substantial Completion established in Engineer's certificate of Substantial Completion.

Article 16—SUSPENSION OF WORK AND TERMINATION

No Supplementary Conditions in this Article.

Article 17—FINAL RESOLUTIONS OF DISPUTES

17.02 *Arbitration*

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

SC-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 (subject to the conditions and limitations of this Paragraph SC-17.02). 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 concurrently 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 arbitration will be held at the Tribe's office.
- D. 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 arbitrator(s) 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.
- E. The Arbitrator(s) 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.
- F. The award of the arbitrator(s) 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.

17.03 *Attorneys' Fees*

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

SC-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.

Article 18—MISCELLANEOUS

SC-18.11 Add a new paragraph immediately after Paragraph 18.10:

SC-18.11 *Confidential Information*

- A. All Drawings, Specifications, technical data, and other information furnished to Contractor either by Owner or Engineer or developed by Contractor or others in connection with the Work are, and will remain, the property of Owner or Engineer, and shall not be copied or otherwise reproduced or used in any way except in connection with the Work or disclosed to third parties or used in any manner detrimental to the interests of Owner or Engineer.
- B. The following information is not subject to the above confidentiality requirements:
 1. information in the public domain through no action of Contractor in breach of the Contract Documents; or
 2. information lawfully possessed by Contractor before receipt from Owner or Engineer; or
 3. information required to be disclosed by Laws or Regulations, or by a court or agency of competent jurisdiction. However, in the event Contractor shall be so required to disclose such information, Contractor shall, prior to disclosure,

provide reasonable notice to Owner and Engineer, who shall have the right to interpose all objections Owner may have to the disclosure of such information.

SC-18.12 Add a new paragraph immediately after Paragraph 18.11, to read as follows:

SC-18.12 *Publicity*

- A. Contractor shall not disclose to any third party the nature of its Work on the Project, nor engage in publicity or public media disclosures with respect to the Project without the prior written consent of Owner.



DIVISION 01

GENERAL REQUIREMENTS



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SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Specification and Drawing conventions.

1.2 PROJECT INFORMATION

- A. Project Identification: Kalama Creek Hatchery Modernization.
 - 1. Project Location: Nisqually, WA.
- B. Owner: Nisqually Indian Tribe.
 - 1. Owner's Representative: Bill St. Jean.
- C. Architect: HDR Engineering

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
 - 1. Demolition of the following:
 - a. Removal of existing well house concrete slab, piping, and decommissioning of well.
 - b. Removal upper site yard piping,
 - c. Removal of concrete headwall, stairs, and upwell of asphalt pond,
 - d. Removal of various building exteriors, doors, and mechanical equipment,
 - e. Removal of concrete slab, stairs, and walls in the adult holding pond.
 - f. And other work indicated in the
 - 2. Construction of the following single story above ground structures:
 - a. Hatchery Treatment Building
 - b. Circular Tank Building
 - c. Adult Holding Building.
 - 3. Construction of the following other structures:
 - a. Creek intake screens
 - b. Pollution abatement ponds
 - c. Lift stations
 - d. Container filter
 - 4. And other Work indicated in the Contract Documents.
- B. Type of Contract:
 - 1. Project will be constructed under a single prime contract.

1.4 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings and Specifications.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements applicable to all substitution requests.
 - 2. Provisions specific to Contractor's substitution requests for:
 - a. Materials and equipment to be incorporated into the Work.
 - b. Methods, procedures, and sequences indicated in the Contract Documents.
- B. Scope:
 - 1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals, and pay all costs associated with requests for approval of substitutes.
 - 2. Where the Contract Documents expressly indicate that substitutes are not allowed, are unacceptable, or time-barred, do not submit substitution requests for such items or procedures.
 - 3. Requirements for Contractor's proposal of "or-equals", where allowed by the Contract, are in the General Conditions, as may be modified by the Supplementary Conditions.

1.2 REFERENCES

- A. Terminology:
 - 1. The following terminology, although not indicated with initial capital letters, has the following meaning in this Section:
 - a. "Or-equal" and "or equal" each means material or equipment items to be incorporated into the completed Work as a functioning whole, or method, procedure, or sequence that, in Engineer's sole opinion, are equivalent to that shown or indicated in the Contract Documents.
 - b. "Substitute" means a proposed materials or equipment to be incorporated into the completed Work as a functioning whole, or a proposed construction method, procedure, or sequence that is not, in Engineer's sole opinion, equivalent to the associated, similar material or equipment item or method, procedure, or sequence shown or indicated in the Contract Documents, but accomplishes the same or similar purpose. Unless expressly indicated otherwise in the Contract Documents, Contractor's proposals for "value engineering" (and similar terms) are substitutes.
 - c. "Substitution request" means Contractor's written request for Engineer's approval of a proposed substitute, in accordance with this Section. Substitution requests are separate from Shop drawings and other Submittals required by the Contract Documents.

1.3 SUBSTITUTES - GENERAL

- A. This Article applies to all substitutes and substitution requests, whether for substitute materials or equipment, or for substitute methods, procedures, or sequences.
- B. This Section expands on the provisions on substitutes in the General Conditions, as may be modified by the Supplementary Conditions.
- C. Time Limits for Submitting Substitution Requests:
 - 1. Where the Contract allows Contractor's substitution requests, such proposals will be considered by Engineer only during a period of 30 days after the date the Contract Times start to run, unless otherwise indicated.
 - 2. Substitution requests will be accepted for consideration by Engineer after the time limit indicated in the paragraph above this, when materials or equipment shown or indicated, and all associated "or-equals", are either:
 - a. Unavailable; or

- b. Despite Contractor's due diligence, are unavailable in time for the Work to be completed within the Contract Times.
 - 3. The foregoing notwithstanding, substitutes will not be approved when received by Engineer after Contractor has commenced the associated Work at the Site, where approval of the substitute would require rework or removing Work already installed.
- D. Design Professional:
 - 1. Engineer is responsible for design of the completed Project as a functioning whole and has responsible charge of the Project except for Work for which design responsibility is expressly delegated by the Contract Documents.
 - 2. Do not retain services of any third-party design professional to prepare modifications of Engineer's design of the completed Project as a functioning whole without Engineer's express, written consent via an appropriate Contract modification setting forth appropriate performance and design criteria for delegating the design of the substitute.
- E. Contractor's Representations:
 - 1. In submitting each substitution request, Contractor represents that:
 - a. Contractor has read and understands the Contract's provisions on substitutes, as indicated in this Section, and elsewhere in the Contract Documents.
 - b. Substitution request is complete and includes all documents and information required by the Contract Documents.
 - c. Contractor certifications required by the General Conditions, as may be modified by the Supplementary Conditions, and this Section are valid and made with Contractor's full knowledge, information, and belief.
 - d. Contractor will provide the same or better guarantees and warranties for substitute as for the specified materials, equipment, methods, procedures, and sequences (as applicable).
 - e. Contractor waives all rights for increasing the Contract Price or extending the Contract Times, related to the substitute, that subsequently may become apparent to Contractor after issuance of the associated Contract modification instrument approving such substitute, except for those associated with differing subsurface or physical conditions or discovery of a previously unforeseen Hazardous Environmental Condition associated with the Work involving the approved substitute.
- F. Submittal of Substitution Requests - General:
 - 1. Substitution requests must be submitted by Contractor. Engineer will not accept or review substitution requests from prospective or bona-fide Subcontractors or Suppliers.
 - 2. Submit separate substitution request for each proposed substitute.
 - 3. Submit substitution requests in accordance with requirements for Shop Drawings and other Submittals, as indicated in the General Conditions, as may be modified by the Supplementary Conditions, Section 01 33 00 - Submittal Procedures.
 - 4. Do not submit substitution requests as any of the following (such substitution requests will be returned by Engineer without review):
 - a. Shop Drawing, Sample, or other Submittal.
 - b. Request for approval of an "or-equal".
 - c. Request for interpretation (RFI) or clarification.
 - d. Change Proposal without all other, required substitution request elements indicated below.
 - e. Other oral or written communication not in accordance with this Section.
 - 5. Each substitution request shall include:
 - a. Transmittal letter (one per substitution request) expressly indicating the communication is a substitution request.
 - b. Completed substitution request form, on the form attached to this Section.
 - c. Change Proposal, submitted in accordance with the Contract Documents. Clearly indicate the proposed changes in Contract Price and Contract Times if substitute is approved; if none, clearly so indicate on the Change Proposal.

- d. Certifications and written representations required by the Contract Documents to accompany substitution requests.
 - e. Other information: (1) required elsewhere in this Section and in other elements of the Contract Documents, and (2) deemed appropriate by Contractor to support Contractor's substitution request.
 - 6. When Engineer requires additional information to evaluate a substitution request, furnish such information within five days of receipt of Engineer's request, unless additional time is granted by Engineer, in writing.
 - 7. Engineer and Owner have the right to rely upon the completeness and accuracy of information, documents, certifications, and representations in Contractor's substitution request. Contractor accepts full responsibility for completeness and accuracy of substitution requests (except for Engineer's professional liability).
- G. Engineer's Review of Substitution Requests:
- 1. Engineer has no obligation to approve any substitute.
 - 2. Substitutes will not be approved unless all of the following are satisfied for the associated substitute:
 - a. The Contract supports submittal of such substitution request; and
 - b. Substitute is reasonably consistent with Engineer's design intent for the Project as a completed, functioning whole; and
 - c. As indicated in Paragraph 1.3.A.3 of this Section.
 - d. Substitute will not have an adverse effect on the work of other contractors, or existing or proposed construction; and
 - e. Substitution request is complete in accordance with the Contract Documents and Engineer's requests, and
 - f. Owner agrees to the substitute; and
 - g. Associated changes in Contract Price and Contract Times, if any, are acceptable to Owner.
 - 3. Engineer is not obligated to approve any substitute where such approval is conditioned on an increase in the Contract Price, the Contract Times, or both.
 - 4. Timeliness of Engineer's Review:
 - a. Allow not less than 14 days for Engineer's review of each substitute. Allow longer for larger, more-complex substitutes.
 - b. Engineer will endeavor to perform timely review of substitution requests. However, Contractor is responsible for complying with the Contract Times, regardless of whether the substitute is approved.
 - c. Where approval of a substitute would necessitate other changes to the Project's design, additional time, beyond that indicated above, will be necessary for Engineer's preparation of revisions to the design.
 - 5. When Design Changes are Required with Approval of Substitute:
 - a. Engineer will advise Contractor promptly following Engineer's review (and Owner's comment, if any) on substitution request to indicate whether the substitute will be acceptable. Engineer's advisory to Contractor will indicate whether changes in Engineer's design are necessary and include a preliminary estimate of Engineer's fee and time required for modifying the design and preparing an associated Proposal Request to Contractor.
 - b. Engineer's preliminary estimates of fee and time for design modifications will be prepared in good faith, but are not binding on Owner or Engineer.
 - c. Contractor shall reimburse Owner for costs incurred by Owner for design modifications necessitated by approval of substitute. Owner may deduct such amounts, as one or more set-offs, from payments due Contractor under the Contract.
 - d. Upon Contractor's receipt of Engineer's estimate of fee and time for design modifications, contractor shall advise Engineer, in writing, within three days whether Contractor will continue pursuing approval of the substitute.
 - e. Request to Contractor.

- f. Engineer may reject a substitute that would require substantial changes in the Project's design.
- H. Approval of Substitutes:
 - 1. Approval of a substitute does not relieve Contractor from obligation to comply with the Contract Documents, including submitting Shop Drawings, Samples, and other Submittals in accordance with the Contract Documents.

1.4 SUBSTITUTE MATERIALS AND EQUIPMENT

- A. In addition to other requirements of this Section and elsewhere in the Contract Documents, substitution requests for substitute materials or equipment shall include:
 - 1. Manufacturer and Location:
 - a. Name and address of manufacturer of the proposed substitute. Indicate country where manufacturer is incorporated and owned.
 - b. Companies and brands owned by or affiliated with manufacturer.
 - c. Name of manufacturers of principal component items, such as motors, bearings, and similar items.
 - d. Location where the items would be manufactured, including country and address. Indicate the total percentage of the items' value that will be manufactured outside of the United States and its territories.
 - e. Name, address, and driving distance from the Site of:
 - 1) Manufacturer's sales representative.
 - 2) Nearest service center offering full array of service capabilities.
 - 3) Warehouse or other location where spare parts for the proposed substitute are available.
 - f. Number of years that manufacturer has actively participated the North American market.
 - 2. Proposed Materials and Equipment:
 - a. Model designation and quantity of each proposed for the Work.
 - b. Manufacturer's literature for proposed substitute, with description of the materials and equipment.
 - c. Performance information and representative test data.
 - d. Indication of reference standards with which materials and equipment comply.
 - e. Preliminary process and instrumentation diagrams (P&ID), where applicable.
 - f. Identification of hazardous materials, including Constituents of Concern, used in the materials and equipment, and associated permitting or licensing required.
 - g. Manufacturer's standard warranty and applicable, proposed special or extended warranties, including indication of specific entities that will be beneficiary of such warranties.
 - h. Complete list of proposed deviations from requirements of the Contract Documents.
 - i. Itemized comparison of specified materials and equipment and proposed substitute, indicating:
 - 1) Size (physical dimensions) when: item is in use, when not in use, and space required for routine and major maintenance.
 - 2) Weight and loading at supports, when item is full and empty.
 - 3. Operation requirements, including:
 - a. Anticipated consumption of each item of: Electricity, other energy sources, water, chemicals (indicate each), and other needs for operation at the Site.
 - b. Typical labor required for operation and associated skill level.
 - c. Description of remote monitoring and control capabilities, as applicable.
 - 4. Maintenance requirements, including:
 - a. Anticipated life in the service and environment required.
 - b. Frequency and general scope of routine and major maintenance typically necessary.
 - c. Typical labor requirements and general qualifications of personnel performing routine maintenance.

- d. Major, associated equipment necessary for routing and major maintenance, including hoisting equipment type and capacity (when applicable).
- e. Availability, scope, cost, and general conditions of service and maintenance contracts, if any.
5. References for similar projects on which the materials and equipment were used. Indicate for each:
 - a. Project owner name, name of facility where installed, and name of project.
 - b. City, state, and country of installation.
 - c. Model number/size and quantity furnished and installed.
 - d. Year of installation.
 - e. Contact information for owner and design professional, including telephone numbers.
6. Other information required by the Contract Documents.
7. Other information reasonably requested by Engineer.

1.5 SUBSTITUTE CONSTRUCTION METHODS, PROCEDURES, OR SEQUENCES

- A. Provisions of the General Conditions, as may be modified by the Supplementary Conditions, regarding substitutes of materials and equipment are hereby extended to apply to substitute methods, procedures, and sequences as shown or indicated in the Contract Documents.
- B. In addition to other requirements of this Section and elsewhere in the Contract Documents, substitution requests for substitute methods, procedures, or sequences shall include:
 1. Clear identification of the method, procedure, or sequence shown or indicated in the Contract Documents for which substitute is requested.
 2. Detailed description of proposed substitute method, procedure, sequence, or combination thereof.
 3. Reasons why substitute is proposed and benefits to the Project should the substitute be approved.
 4. Detailed list of how the proposed substitute deviates from associated method, procedure, or sequence shown or indicated in the Contract Documents.
 5. Impact of the substitute, if approved, on Owner's or facility manager's operations, when the Work is at an existing facility.
 6. Effect on other contractors working at the Site, if substitute is approved.
 7. Description of temporary equipment and temporary facilities needed, should the substitute be approved, including quantity of items, capacities, performance characteristics, permitting and approvals required by authorities having jurisdiction, and proposed location at the Site.
 8. Written evaluation of how substitute method, procedure, or sequence complies with Laws and Regulations.
 9. Drawings illustrating method, procedure, or sequence.
 10. Materials to be used that contain Constituents of Concern or that have potential to cause or exacerbate a Hazardous Environmental Condition.
 11. Other information and data required by the Contract Documents.
 12. Other information reasonably required by Engineer.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

- A. The following, bound after this Section's "End of Section" designation, are part of this Specifications Section:
 1. Exhibit A - Substitution Request Form (one page).

END OF SECTION

EXHIBIT A

Substitution Request Form

(One Item per each Form)

Project:		Date:	
Substitution Requestor:			
Contractor:			
Specification Section No:	Paragraph No. (i.e. 2.1.A.1.c):	Specified Item:	
Proposed Substitution:			
Provide Product Data Sheets, Manufacturer's written installation instructions, drawings, diagrams, or any other information as an attached to this Form that will demonstrate the proposed substitution is an Approved Equal.			
State differences between proposed substitutions and specified item. Differences include but are not limited to interrelationship with other items; materials, equipment, function, utility, life cycle costs, applied finished, appearances, and quality.			
Document how the proposed substitution is compatible with or modifies other systems, parts, equipment or components of the Project and Work under the Contract			
Describe what effect the proposed substitution has on dimensions indicated on the Drawings and previously reviewed Shop Drawings?			
Describe what effect the proposed substitution has on the Construction Schedule and Contract Time.			
Describe what effect the proposed substitution has on the Contract Price. This includes all direct, indirect, impact and delay costs.			
Manufacturer's guarantees of the proposed and specified items are: ☐ Same ☐ Different (explain on attachment)			
The undersigned state that the function, utility, life cycle costs, applied finishes, appearance and quality of the proposed substitution are equal or superior to those of the specified item.			
For use by Engineer: ☐ Accepted – eligible for approval via Change Order ☐ Accepted as Noted – approval via Change Order ☐ Not Accepted _____ Date _____ (Telephone): _____ Signature of PE, RA, or PG in Responsible Charge		_____ (Contractor's Signature) _____ (Contractor's Firm) _____ (Firms Address) _____ (Telephone)	

Comments:

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SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Preconstruction, progress and other project meetings.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 PRECONSTRUCTION MEETING

- A. Meet with the Owner and Engineer for a pre-construction conference at a time mutually agreed upon after the contract is awarded, but before any work is performed,
- B. The Engineer will schedule a meeting of the Owner, Contractor, Contractor's Subcontractors, and their respective representatives.
 - 1. The purpose of the meeting will be to clarify construction contract administration procedures, to establish lines of authority and communication and identify duties and responsibilities of the parties.
- C. The Engineer will schedule the pre-construction conference after receipt of the Contractor's draft proposed schedule.
- D. Agenda:
 - 1. Procedural and Administrative:
 - a. Personnel and Teams:
 - 1) Designation of roles and personnel.
 - 2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
 - 3) Subcontractors and Suppliers in attendance.
 - 4) Authorities having jurisdiction.
 - b. Procedures for communications and correspondence, including electronic communication protocols.
 - c. Copies of the Contract Documents and availability.
 - d. The Work and Scheduling:
 - 1) General scope of the Work.
 - 2) Contract Times, including Milestones (if any).
 - 3) Phasing and sequencing.
 - 4) Preliminary Progress Schedule.
 - 5) Critical path activities.
 - e. Safety:
 - 1) Responsibility for safety.
 - 2) Contractor's safety representative.
 - 3) Emergency procedures and accident reporting.
 - 4) Emergency contact information.
 - 5) Confined space entry permits.
 - 6) Hazardous materials communication program.
 - 7) Impact of Project on public safety.
 - f. Permits.
 - g. Review of insurance requirements and insurance claims.
 - h. Coordination:
 - 1) Coordination of Subcontractors and Suppliers.

- 2) Construction coordinator (for projects with multiple prime construction contracts).
- 3) Coordination with Owner's operations.
- 4) Progress meetings – schedule and frequency.
- 5) Coordination meetings.
- i. Submittals:
 - 1) Current critical Submittals:
 - a) Preliminary Schedule of Submittals.
 - b) Other schedules (Progress Schedule, Schedule of Values).
 - c) Preconstruction photographic documentation.
 - d) List of proposed Subcontractors and Suppliers.
 - e) List of emergency contact information.
 - f) Notice of elements of Contractor's safety program with which Owner and Engineer are to comply.
 - g) Site use plan.
 - h) Form of Contractor's site superintendent's daily reports.
 - 2) Work not eligible for payment without approved or accepted Submittals (as applicable).
 - 3) Submittal procedures.
 - a) Compliance with accepted Schedule of Submittals.
 - b) Actions required of Contractor prior to furnishing Shop Drawings and other Submittals
 - c) Contractor's Submittal approval stamp required; Contractor's coordination of Submittals.
 - d) Furnishing of Submittals.
 - e) Submittal types and meaning of Engineer's action on each
 - f) Resubmittals—responsibility for, limitations on quantity.
 - 4) Identification of initial, critical Shop Drawings and product data.
 - 5) Construction photographic documentation.
- j. Substitutes and "Or-Equals":
 - 1) Product options.
 - 2) Procedures for proposing "or-equals".
 - 3) Procedures for proposing substitutes.
- k. Contract Modification Procedures:
 - 1) Requests for interpretation.
 - 2) Written clarifications.
 - 3) Field Orders.
 - 4) Proposal Requests.
 - 5) Change Proposals.
 - 6) Work Change Directives.
 - 7) Change Orders.
 - 8) Differing site conditions or discovery of Hazardous Environmental Condition.
 - 9) Substantiating and documenting Change Proposals and Claims.
 - 10) Claims.
- l. Progress Payment:
 - 1) Owner's Project financing and funding, as applicable.
 - 2) Owner's tax-exempt status.
 - 3) Preliminary Schedule of Values
 - 4) Procedures for measuring for payment (Unit Price Work).
 - 5) Retainage.
 - 6) Progress payment procedures; documents to accompany Applications for Payment.
 - 7) Payment for stored items not yet installed.
 - 8) Date of Owner's payments; payment is due.
- m. Subcontractors and Suppliers:
 - 1) List of proposed Subcontractors and Suppliers; monthly updates.
 - 2) Coordination and management.
 - 3) Subcontracts and purchase orders.

- 4) Diversity Business Enterprises (MBE, WBE, DBE, VBE, etc.) – when applicable:
 - a) Goals.
 - b) Progress reports.
 - c) Requests for waivers.
- n. Testing and inspections:
 - 1) Owner-hired and contractor-hired.
 - 2) Identification of Owner-hired testing entity and special inspectors.
 - 3) Responsibility for advising testing entity and special inspectors of need for services.
 - 4) Results of code-required special inspections and tests.
 - 5) Prompt remedy of apparent defects.
 - 6) Notice of defective Work.
 - 7) Remedy of defective Work.
 - 8) Defective Work not eligible for payment.
 - 9) Covering up defective Work.
 - 10) Cost responsibility for defective Work and retesting/re-inspection.
- o. Disposal of demolition materials.
- p. Record documents.
- q. Preliminary discussion of Contract closeout:
 - 1) Procedures for Substantial Completion.
 - 2) Partial utilization procedures; property insurance.
 - 3) Contract closeout requirements.
 - 4) Correction period; duration of Contractor's general warranty and guarantee.
 - 5) Duration of bonds and insurance.
- 2. Authorities Having Jurisdiction (if not covered in a separate meeting):
 - a. Municipal licenses.
 - b. Municipal permits required.
 - 1) Permits required and status.
 - 2) Inspections for building code official.
 - 3) Code-required special inspections and tests (if not covered in Administrative and Procedures part of meeting).
 - c. Right-of-way work permits; status of occupancy permit(s).
 - d. Environmental permits:
 - 1) Spill prevention control and countermeasures plan (40 CFR 112).
- 3. Site Mobilization (if not covered in a separate meeting):
 - a. Working days, working hours, and overtime.
 - b. Use of Site and other areas; use of existing facilities.
 - c. Field offices, storage trailers, and staging areas.
 - d. Temporary facilities.
 - e. Temporary utilities and limitations on utility use (where applicable).
 - f. Utility company coordination (if not done as a separate meeting).
 - g. Access to Site, access roads, and parking for construction vehicles.
 - h. Traffic controls.
 - i. Temporary controls:
 - 1) Erosion and sediment control; storm water pollution prevention plans.
 - 2) Dust control and air pollution control (including emissions control).
 - 3) Water control (storm water, surface water, groundwater).
 - 4) Water pollution control; spill prevention control and countermeasures plan.
 - 5) Solid waste control.
 - 6) Pest control.
 - 7) Other temporary controls.
 - j. Security; temporary security fencing (where required).
 - k. Storage of materials and equipment to be incorporated into the Work.
 - l. Protection of the Work and property; protective barriers.
 - m. Field engineering:
 - 1) Reference points and benchmarks.

- 2) Surveys and layouts.
 - 3) Professional services for Contractor's means and methods (not delegated design).
 - 4) Contractor's site superintendent's daily records and submittal requirements.
 - n. Site maintenance during the Project:
 - 1) Progress cleaning; removal of trash and debris.
 - 2) Maintenance and cleaning of existing access roads and parking areas.
 - o. Restoration.
 - 4. Next meeting.
 - 5. Site visit, as necessary.
- E. The Engineer will compile meeting minutes from the transcribed record of the meeting and electronically distribute copies to all participants.
- F. Pre-Construction Conference Submittals:
- 1. The names and telephone numbers of Contractor's Superintendent and Office Manager.
 - 2. List of personnel authorized to sign change orders and receive progress payments.
 - 3. The name, address and telephone numbers of two or more persons employed by the Contractor who can be reached at any time of the day or night to handle emergency matters.
 - 4. A list of all subcontractors that will work on the project, a description of work they will perform, and a contact list for each subcontractor with phone numbers and address.
 - 5. A draft proposed Construction Schedule.
 - 6. Material Safety Data Sheets for all hazardous chemical products to be used by the Contractor on this project.
 - 7. Temporary Erosion and Sediment Controls Plan.
 - 8. Traffic Control Plan.

1.3 PROGRESS MEETINGS

- A. Monthly Bi-Weekly progress meetings will be held a location determined by the Engineer, unless otherwise arranged.
- B. Attendees will include the Owner, Engineer, Contractor, subcontractors, and suppliers' representatives as may be needed, other Contractors working at the site, and other interested or affected parties.
- C. Preliminary Agenda: Be prepared to discuss in detail the topics indicated below. Revised agenda, if any, will be furnished to Contractor prior to associated progress meeting(s). Progress meeting agenda may be modified by Engineer during the Project as necessary.
 - 1. Review, comment, and amendment (if necessary) of minutes of previous progress meeting.
 - 2. Review of progress since the previous progress meeting.
 - 3. Planned progress through next progress meeting.
 - 4. Review of Progress Schedule:
 - a. Review of the Contract Times; Contractor's ability to comply with Contract Times.
 - b. Identification of critical path activities.
 - c. Schedules for fabrication and delivery of materials and equipment.
 - d. Corrective measures, if necessary, including recovery schedule(s).
 - 5. Submittals:
 - a. Review status of critical Submittals.
 - b. Review revisions to Schedule of Submittals.
 - 6. Contract Modifications:
 - a. Requests for interpretation.
 - b. Written clarifications.
 - c. Field Orders.
 - d. Proposal Requests.
 - e. Change Proposals.
 - f. Work Change Directives.
 - g. Change Orders.
 - h. Claims.

7. Applications for progress payments:
 - a. Status and deadline for submittal.
 - b. Stored materials and equipment; observation by Engineer or RPR; documents required.
 - c. Set-offs to which Owner is entitled (as applicable).
 - d. Other matters related to progress payments.
 8. Problems, conflicts, and observations.
 9. Quality standards, testing, and inspections.
 10. Coordination between Project participants.
 11. Site management issues, including vehicular access and parking, traffic control, security, status of temporary controls and temporary utilities, site maintenance and cleaning, and other Site matters.
 12. Safety and protection.
 13. Permits.
 14. Construction photographic documentation.
 15. Record documents status.
 16. Completion matters (as appropriate):
 - a. Status of checkout, startup, field quality control activities.
 - b. Status of training of facility O&M personnel and O&M manuals.
 - c. Partial utilization; inspection for Substantial Completion.
 - d. Punch list status (as applicable).
 - e. Other closeout matters (if any).
 17. Other business.
- D. Bring a four-week look ahead schedule to each meeting, including the following items:
1. Work completed last week.
 2. Work anticipated for the next two weeks ("Look Ahead").
 3. Subcontractors on site the prior week.
 4. Subcontractors scheduled on site for the next two weeks.
 5. Contract document deficiencies or questions noted during prior week.
 6. Anything that could impede the progress of the work or affect the critical path on the project schedule.
 7. Corrective measures and procedures planned to regain planned schedule, cost or quality assurance, if necessary.
 8. Report of any accidents, and any site safety issues that need to be addressed.
- E. Other Agenda items to be discussed:
1. Review and revise as necessary and approve minutes of previous meetings.
 2. Status of submittals of equipment and shop drawings.
 3. Identify problems that impede planned progress.
 4. Other current business.
- F. Revision of Minutes:
1. Unless published minutes are challenged in writing prior to the next regularly scheduled progress meeting, they will be accepted as properly stating the activities and decisions of the meeting.
 2. Persons challenging published minutes shall reproduce and distribute copies of the challenge to all indicated recipients of the particular set of minutes.
 3. Challenge to minutes shall be settled as priority item of "old business" at the next regularly scheduled meeting.
- G. Minutes of Meeting:
1. The Engineer will compile minutes of each project meeting and will furnish electronic copies to the Contractor.

1.4 OTHER MEETINGS

- A. Other meetings will be required to facilitate progress of the Work. These include, but are not limited to the following:
 - 1. Pre-Installation Conferences:
 - a. Coordinate and schedule with Engineer for each material, product or system specified.
 - 1) Conferences to be held prior to initiating installation, but not more than two weeks before scheduled initiation of installation.
 - 2) Conferences may be combined if installation schedule of multiple components occurs within the same two week interval.
 - 3) Review manufacturers recommendations and Contract Documents Specification Sections.
 - 2. Facility Startup Planning and Coordination Meeting. See Section 01 75 00.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Includes:
1. Upon award of the Contract, Contractor shall prepare and submit a Contractor's construction schedule for the Work for the Owner's and Architect's information.
 - a. Submit in expeditious manner.
 - b. Schedule shall not exceed time limits current under Contract Documents, shall be revised at appropriate intervals as required by conditions of the Work and Project, shall be related to entire Project to extent required by Contract Documents, and shall provide for expeditious and practicable execution of Work.
 2. Coordinate Subcontractors' schedules for entire Project:
 - a. Secure time commitments for performing critical elements of Work from parties involved.
 - b. Coordinate each element on the schedule with other construction activities; include minor elements involved in sequence of Work.
 - c. Show each activity in proper sequence.
 - d. Indicate graphically the sequences necessary for completion of related portions of Work.
 - e. Resolve conflicts among schedules of Subcontractors.
 - f. Revise as required by conditions and progress of Work.
 - g. Furnish copy of schedules for entire Project to each Subcontractor.
 3. Contractor shall perform Work in general accordance with most recent schedules submitted to Owner and Architect.

1.2 SUBMITTALS

- A. Project Information:
1. Preliminary Construction Schedule:
 - a. Submit to Owner and Architect prior to date set for Preconstruction Conference and prior to start of Work.
 2. Project Schedules:
 - a. Provide to Owner and Architect within 60 days of start of construction.
 3. Updated Project Schedules:
 - a. Provide to Owner and Architect quarterly.
 - b. Provide if completion date is revised or sequence of Work is revised.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 FORM OF SCHEDULES

- A. Horizontal Bar Chart:
1. Provide separate horizontal bar column for each line item of the approved Schedule of Values.
 2. Indicate each bar with start and completion date of each item, its total dollar value percent to be completed for each month.
 3. Identify each bar column:
 - a. By specification section number, Work element and major component.
 - b. By distinct graphic delineation.

4. Horizontal time scale:
 - a. Identify first week day of each week.
 5. Scale and spacing:
 - a. Allow space for updating.
 6. As Work progresses, place contrasting mark in each bar to indicate actual progress and completion.
- B. Sheet Size:
1. Maximum 280 x 430 MM 11 x 17 IN.
- C. CPM Schedule:
1. Furnish a CPM schedule covering items of construction with, as a minimum, early/late start and early/late finish and normal float.

3.2 CONTENT OF SCHEDULES

- A. Provide complete sequence of construction by activity.
1. Shop drawings, product data and samples:
 - a. Submittal dates as indicated in approved Submittal Schedule.
 - b. Dates reviewed copies will be required.
 2. Decision dates for:
 - a. Selection of finishes.
 3. Product procurement and delivery dates.
 4. Dates product information and delivery of Owner furnished, installed equipment and materials is needed.
- B. Dates for early and late beginning, and completion of each element of construction.
- C. Identify Work of separate floors, or separate phases, or other logically grouped activities.
- D. Show how requirements for phased completion and partial occupancy by Owner affect sequence of Work.
- E. Indicate important stages of construction for each major portion of Work, including submittal review, testing, and installation.
- F. Identify punch list preparation and completion durations, agencies inspections, and Owner occupancy dates.
- G. Show projected percentage of completion for each item of Work as of last day of every month.
- H. Identify restraints and constraints.
- I. Identify critical path and critical portions of entire schedule. There shall be only one critical path and it shall be clearly identified.

3.3 UPDATING

- A. Show changes occurring since previous submission of updated schedules.
- B. Indicate progress of each activity, actual versus scheduled start and completion dates, and actual versus scheduled percent complete by month.
- C. Include:
1. Major changes in scope.
 2. Activities modified since previous updating.
 3. Review projections due to changes.
 4. Other identifiable changes.
- D. Provide Narrative report Including:
1. Discussion of problem areas including current and anticipated delay factors and their impact.
 2. Corrective action taken or proposed and its effect.
 3. Effect of change in schedule.

4. Description of revisions.
 - a. Effect on schedule due to changes to Contract.
 - b. Revisions in duration of activities.
 - c. Other changes that may affect schedule.

3.4 DISTRIBUTION

- A. Distribute copies of revised schedules to:
 1. Owner.
 2. Architect.
 3. Contractors/Subcontractors.
 4. Other concerned parties.
- B. Instruct recipients to report inability to comply and provide detailed requirements and schedule, with suggested remedies.

END OF SECTION

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SECTION 01 32 26
CONSTRUCTION PROGRESS REPORTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Includes:
 - 1. Preconstruction photographs.
 - 2. Taking and submission of monthly progress photographs.
 - 3. Compilation and submission of monthly progress reports.
 - 4. Final completion construction photographs.

1.2 SUBMITTALS

- A. Project Information:
 - 1. Progress Report:
 - a. Submit monthly prior to or with Application for Payment.
 - 1) Prepare written portion of report in Microsoft Word format.
 - 2. Progress Photos and Videos:
 - a. Key plans:
 - 1) Submit plans (site, floor, etc. as appropriate) of project site/building with notation of vantage points marked for location and direction of each photograph and video recording.
 - b. Locating hidden features:
 - 1) Photograph walls, partitions, and ceilings, etc. prior to closure for the purpose of locating devices, backing, gases, conduits, etc. for future owner use.
 - 2) Indicate locations on separate key plans.
 - 3) Save key plans in a separate file/folder.
 - c. Submit electronically.
 - 3. Contract Closeout:
 - a. Submit indexed set of digital progress photographs electronically using agreed upon file transfer protocol (FTP).
 - 1) E-mail files are not acceptable.

PART 2 - PRODUCTS

2.1 MEDIA

- A. Digital images – provide in electronic format.
 - 1. Minimum 10 megapixels resolution.
 - 2. GPS geo-tagging capable.
 - 3. JPEG, PDF, FIFF or similar format.
 - 4. Use a digital camera with a resolution of not less than 3200 by 2400 pixels.
 - 5. Digitally date each photograph.

PART 3 - EXECUTION

3.1 PROGRESS REPORTS

- A. Each Subcontractor shall prepare comprehensive Daily Log and maintain it during entire project period. Submit copy to Contractor for compilation into monthly Progress Reports.
- B. Progress report to include following Summary narrative for entire month.
 - 1. Current total percent complete.
 - 2. Current percent complete of major work activities.

3. Percent of work completed during past month.
 4. Main work activities completed during prior month.
 5. Main work activities in process and scheduled for next month, including major equipment deliveries, system tie-ins and system start-ups.
 6. Overall status of project compared with project schedule.
 7. Delays or potential delays, if any.
- C. Daily logs to include following data for each day of prior month.
1. Manpower, by trade.
 2. Work performed, with location.
 3. Weather.
 4. Situations or circumstances which could delay work or give cause for claims for extension of time or added cost.
 5. List of visitors names, to include officials, Owner's representatives, and other authorities.

3.2 PROGRESS PHOTOGRAPHS

- A. Submit digital progress photographs by agreed upon method.
- B. Take photos using the maximum range of depth of field, in focus, to clearly show work.
1. Photos with blurry and out-of-focus areas will not be accepted.
- C. Photograph/file naming:
1. Include date (YRMODY), Building or Area, Direction photo taken (N.S.E.W.), and Description of Subject.
 2. File name example: 07 04 12_Area-A1_NE_AHU-6.jpeg.
- D. Provide identification with each photograph including following information:
1. Name of project.
 2. Name and contact of photographer.
 3. Name of Contractor.
 4. Date photo was taken.
 5. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 6. Unique sequential identifier keyed to each accompanying key plan.
 7. Incorporate digital photos and link to electronic as-built documentation.
 8. Provide index of submitted digital photos.
- E. Submit digital images as originally recorded in the digital camera without alteration, manipulation, editing or modifications using image-editing software.
- F. Maintain one set of images accessible in the field office at Project Site. Make images available during work hours for reference.

3.3 PRECONSTRUCTION PHOTOGRAPHS

- A. Before start of each demolition phase of work take photographs of project site and adjacent construction including existing items to remain during demolition and construction.
- B. Photograph again before start of construction phase of work

3.4 PERIODIC CONSTRUCTION PHOTOGRAPHS

- A. Building Exterior:
1. Minimum 12 digital photos monthly until project exterior is finished.
 2. Take photos from different view points of interest related to current progress.
- B. Building Interior:
1. Minimum 20 digital photos weekly until project interior is finished.
 2. Take photos from different view points of interest related to current progress.

3.5 ADDITIONAL PHOTOGRAPHS

- A. Owner may request photographs in addition to periodic photos specified. Additional photos will be paid for by change order and are not included in contract sum. May include but not be limited by the following circumstances:
1. Special events scheduled at project site.
 2. In emergency situations, take photos as soon as possible.
 3. Photos of construction damage on-site shall be taken immediately.
 4. Photos taken off-site, at fabrication locations.
 5. Substantial completion of a major phase or component of work.
 6. Extra photos requested by owner for publicity purposes.

END OF SECTION

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SECTION 01 33 00

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mechanics and administration of the submittal process for:
 - a. Shop Drawings.
 - b. Samples.
 - c. Informational submittals.
 - 2. General content requirements for Shop Drawings.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Construction Progress Schedule submittal requirements are specified in Specification Section 01 32 16.
 - 4. Operations and Maintenance Manual submittal requirements are specified in Specification Section 01 33 04.
 - 5. Technical Specification Sections identifying required submittals.

1.2 DEFINITIONS

- A. Action Submittals:
 - 1. Action Submittals require an explicit, written approval or other appropriate action by Engineer before Contractor may release the associated item(s) for raw materials procurement, fabrication, production, and shipment.
 - 2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
 - a. Shop Drawings.
 - b. Product data.
 - c. Samples.
 - d. Testing plans for quality control activities required by the Contract Documents.
 - e. Delegated Designs: Design drawings, design specifications, calculations, reports, and other instruments of service sealed and signed by design professional retained by Contractor, Subcontractor, or Supplier for a portion of the completed Work as part of the completed Project. Engineer's approval or other appropriate action on such delegated design Submittals will be only for the limited purposes set forth in the General Conditions.
- B. Informational Submittals:
 - 1. Informational Submittals are Submittals, other than Action Submittals, required by the Contract Documents. Explicit response from Engineer is not required when such Submittal is acceptable and Engineer's acceptance thereof will be indicated in the Engineer's Submittals log. When Informational Submittal does not indicate full compliance with the Contract Documents, Engineer will indicate the non-compliance in a written response to Contractor.
 - 2. Representative types of informational submittal items include but are not limited to:
 - a. HVAC test and balance reports.
 - b. Installed equipment and systems performance test reports.
 - c. Manufacturer's installation certification letters.
 - d. Instrumentation and control commissioning reports.
 - e. Warranties.
 - f. Service agreements.

- g. Construction photographs.
 - h. Survey data.
 - i. Work plans.
 - j. Shop Drawings, product data, Samples, and testing plans, submitted as a requirement of for delegated designs, bearing the Submittal approval stamp of associated design professional retained by Contractor, Subcontractor, or Supplier.
3. For-Information-Only submittals upon which the Engineer is not expected to conduct review or take responsive action may be so identified in the Contract Documents.

1.3 SUBMITTAL SCHEDULE

- A. Schedule of Shop Drawings:
 - 1. Submitted and approved within 20 days of receipt of Notice to Proceed.
 - 2. Account for multiple transmittals under any specification section where partial submittals will be transmitted.
- B. Shop Drawings: Submittal and approval prior to 30 PCT completion of project.
- C. Informational Submittals:
 - 1. Reports and installation certifications submitted within seven days of conducting testing, installation, or examination.
 - 2. Submittals showing compliance with required qualifications submitted 20 days prior to any work beginning using the subject qualifications.
- D. The submittal schedule shall include the following columns as a minimum:

Submittal Section	Submittal Description	Planned Submittal Date	Submittal Need Date	Actual Submittal Date	Actual Return Date	Disposition

1.4 PREPARATION OF SUBMITTALS

- A. General:
 - 1. All submittals and all pages of all copies of a submittal shall be completely legible.
 - 2. Submittals which, in the Engineer's sole opinion, are illegible will be returned without review.
 - 3. Minimize extraneous information for equipment and products not relevant to the submittal.
 - 4. Contractors or vendors written comments on the submittal drawings shall be in green
- B. Shop Drawings, Product Data, and Samples:
 - 1. Scope of any submittal and letter of transmittal:
 - a. Limited to one Specification Section.
 - b. Submittals with more than one Specification section included will be rejected.
 - c. Do not submit under any Specification Section entitled (in part) "Basic Requirements" unless the product or material submitted is specified, in total, in a "Basic Requirements" Specification Section.
 - 2. Numbering letter of transmittal:
 - a. Include as prefix the Specification Section number followed by a series number, "-xx", beginning with "01" and increasing sequentially with each additional transmittal for that Specification Section.
 - b. If more than one submittal under any Specification Section, assign consecutive series numbers to subsequent transmittal letters.
 - 3. Describing transmittal contents:
 - a. Provide listing of each component or item in submittal capable of receiving an independent review action.

- b. Identify for each item:
 - 1) Manufacturer and Manufacturer's Drawing or data number.
 - 2) Contract Document tag number(s).
 - 3) Unique page numbers for each page of each separate item.
- c. When submitting "or-equal" items that are not the products of named manufacturers, include the words "or-equal" in the item description.
- 4. Contractor certification of review and approval:
 - a. Contractor's review and approval certification stamp shall be applied either to the letter of transmittal or a separate sheet preceding each independent item in the submittal.
 - 1) Stamp may be either a wet ink stamp or electronically embedded.
 - 2) Clearly identify the person who reviewed the submittal and the date it was reviewed.
 - 3) Shop Drawing submittal stamp shall read "(Contractor's Name) has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval as stipulated in the General Conditions."

OR

- b. Execute Exhibit AA, Contractor's Submittal Certification form, to indicate Contractor has reviewed and approved the submittal contents.
 - 1) Clearly identify the person who reviewed the submittal and the date it was reviewed."
- c. Submittals containing multiple independent items shall be prepared with each item listed on the letter of transmittal or on an index sheet for all items listing the discrete page numbers for each page of each item, which shall be stamped with the Contractor's review and approval stamp.
 - 1) Each independent item shall have a cover sheet with the transmittal number and item number recorded.
 - a) Provide clear space of 3 IN SQ for Engineer stamping.
 - 2) Individual pages or sheets of independent items shall be numbered in a manner that permits the entire contents of a particular item to be readily recognized and associated with Contractor's certification.
- 5. Resubmittals:
 - a. Number with original Specification Section and series number with a suffix letter starting with "A" on a (new) duplicate transmittal form.
 - b. Do not increase the scope of any prior transmittal.
 - c. Provide cover letter indicating how each "B", "C", or "D" Action from previous submittal was addressed and where the correction is found in the resubmittal.
 - d. Account for all components of prior transmittal.
 - 1) If items in prior transmittal received "A" or "B" Action code, list them and indicate "A" or "B" as appropriate.
 - a) Do not include submittal information for items listed with prior "A" or "B" Action in resubmittal.
 - 2) Indicate "Outstanding-To Be Resubmitted At a Later Date" for any prior "C" or "D" Action item not included in resubmittal.
 - a) Obtain Engineer's approval to exclude items.
- 6. Transmittal contents:
 - a. Coordinate and identify Shop Drawing contents so that all items can be easily verified by the Engineer.
 - b. Provide submittal information or marks defining specific equipment or materials utilized on the Project.
 - 1) Generalized product information, not clearly defining specific equipment or materials to be provided, will be rejected.
 - c. Identify equipment or material project use, tag number, Drawing detail reference, weight, and other Project specific information.
 - d. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.

- e. Do not modify the manufacturer's documentation or data except as specified herein.
 - f. Submit items such as equipment brochures, cuts of fixtures, product data sheets or catalog sheets not exceeding 11 x 17 IN pages.
 - 1) Indicate exact item or model and all options proposed by arrow and leader.
 - g. When a Shop Drawing submittal is called for in any Specification Section, include as appropriate, scaled details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout Drawings, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data in addition to information specifically stipulated in the Specification Section.
 - 1) Arrange data and performance information in format similar to that provided in Contract Documents.
 - 2) Provide, at minimum, the detail specified in the Contract Documents.
 - h. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.
7. Samples:
- a. Identification:
 - 1) Identify sample as to transmittal number, manufacturer, item, use, type, project designation, tag number, Specification Section or Drawing detail reference, color, range, texture, finish and other pertinent data.
 - 2) If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
 - b. Include application specific brochures, and installation instructions.
 - c. Provide Contractor's review and approval certification stamp or Contractor's Submittal Certification form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
 - d. Resubmit revised samples of rejected items.
- C. Informational Submittals:
- 1. Prepare in the format and detail specified in Specification requiring the informational submittal.

1.5 TRANSMITTAL OF SUBMITTALS

A. Shop Drawings and Samples:

- 1. Transmit all submittals to:

HDR
 4717 97th Street
 Gig Harbor, WA 98332
 Attn: Eric Orton
 Email: eric.orton@hdrinc.com

- 2. Utilize two copies of attached Exhibit A to transmit all Shop Drawings and samples.
- 3. All submittals must be from Contractor.
 - a. Submittals will not be received from or returned to subcontractors.

B. Informational Submittals:

- 1. Transmit under Contractor's standard letter of transmittal or letterhead.
- 2. Submit in triplicate or as specified in individual Specification Section.

3. Transmit to:

4717 97th Street
Gig Harbor, WA 98332
Attn: Eric Orton
Email: eric.orton@hdrinc.com

C. Electronic Transmission of Submittals:

1. Transmittals shall be made electronically.
 - a. Use.
 - b. Protocols and processes will be determined at the Pre-Construction Conference.
2. Provide documents in Adobe Acrobat Portable Document Format (PDF), latest version.
3. Do not password protect or lock the PDF document.
4. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
 - a. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 DPI or greater.
 - b. Required signatures may be applied prior to scanning for transmittal.
5. Electronic drawings shall be formatted to be at full-scale (or half-scale when printed to 11x17).
 - a. Do not reduce drawings by more than 50 PCT in size.
 - b. Reduced drawings shall be clearly marked "HALF-SIZE" and shall scale accurately at that size.
6. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
7. Create bookmarks in the bookmarks panel for the cover, the Table of Contents, and each major section of the document.
8. Using Adobe Acrobat Standard or Adobe Acrobat Professional, set the PDF document properties, initial view as follows:
 - a. Select File → Properties → Initial View.
 - b. Select the Navigation tab: Bookmarks Panel and Page.
 - c. Select the Page layout: Single Page.
 - d. Select the Magnification: Fit Page.
 - e. Select Open to page: 1.
 - f. Set the file to open to the cover page with bookmarks to the left, and the first bookmark linked to the cover page.
9. Set the PDF file "Fast Web View" option to open the first several pages of the document while the rest of the document continues to load.
 - a. To do this:
 - 1) Select Edit → Preferences → Documents → Save Settings.
 - 2) Check the Save As optimizes for Fast Web View box.
10. File naming conventions:
 - a. File names shall use the convention (XXXXXX-YY-Z.PDF) where XXXXXX is the Specification Section number, YY is the Shop Drawing Root number and Z is an ID number used to designate the associated volume.
11. Labeling:
 - a. As a minimum, include the following labeling on all electronic media:
 - 1) Project Name.
 - 2) Equipment Name and Project Tag Number.
 - 3) Project Specification Section.
 - 4) Manufacturer Name.
 - 5) Vendor Name.

12. Binding:
 - a. Include labeled electronic media in a protective case.
 - 1) Bind protective case in three-ring binder, inserted at the front of the Final paper copy submittal.
 - 2) Protective case(s) to have means for securing electronic media to prevent loss (e.g., zip case, flap and strap, or equivalent).

1.6 ENGINEER'S REVIEW ACTION

- A. Shop Drawings and Samples:
 1. Items within transmittals will be reviewed for overall design intent and will receive one of the following actions:
 - a. A - FURNISH AS SUBMITTED.
 - b. B - FURNISH AS NOTED (BY ENGINEER).
 - c. C - REVISE AND RESUBMIT.
 - d. D - REJECTED.
 - e. E - ENGINEER'S REVIEW NOT REQUIRED.
 2. Submittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp.
 - a. Submittals not stamped by the Contractor or stamped with a stamp containing language other than that specified herein will not be reviewed for technical content and will be returned rejected.
 3. In relying on the representation on the Contractor's review and approval stamp, Owner and Engineer reserve the right to review and process poorly organized and poorly described submittals as follows:
 - a. Submittals transmitted with a description identifying a single item and found to contain multiple independent items:
 - 1) Review and approval will be limited to the single item described on the transmittal letter.
 - 2) Other items identified in the submittal will:
 - a) Not be logged as received by the Engineer.
 - b) Be removed from the submittal package and returned without review and comment to the Contractor for coordination, description and stamping.
 - c) Be submitted by the Contractor as a new series number, not as a re-submittal number.
 - b. Engineer, at Engineer's discretion, may revise the transmittal letter item list and descriptions, and conduct review.
 - 1) Unless Contractor notifies Engineer in writing that the Engineer's revision of the transmittal letter item list and descriptions was in error, Contractor's review and approval stamp will be deemed to have applied to the entire contents of the submittal package.
 4. Submittals returned with Action "A" or "B" are considered ready for fabrication and installation.
 - a. If for any reason a submittal that has an "A" or "B" Action is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal.
 - b. Destroy or conspicuously mark "SUPERSEDED" all documents having previously received "A" or "B" Action that are superseded by a resubmittal.
 5. Submittals with Action "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected) will be individually analyzed giving consideration as follows:
 - a. The portion of the submittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference).
 - 1) One copy or the one transparency of the "C" or "D" Drawings will be marked up and returned to the Contractor.
 - a) Correct and resubmit items so marked.
 - b. Items marked "A" or "B" will be fully distributed.

- c. If a portion of the items or system proposed are acceptable, however, the major part of the individual Drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" Action.
 - 1) This is at the sole discretion of the Engineer.
 - 2) In this case, some Drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package."
 - 3) Distribution to the Owner and field will not be made (unless previously agreed to otherwise).
6. Failure to include any specific information specified under the submittal paragraphs of the Specifications will result in the submittal being returned to the Contractor with "C" or "D" Action.
7. Calculations required in individual Specification Sections will be received for information purposes only, as evidence calculations have been stamped by the professional as defined in the specifications and for limited purpose of checking conformance with given performance and design criteria. The Engineer is not responsible for checking the accuracy of the calculations and the calculations will be returned stamped "E. Engineer's Review Not Required" to acknowledge receipt.
8. Furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
9. Transmittals of submittals which the Engineer considers as "Not Required" submittal information, which is supplemental to but not essential to prior submitted information, or items of information in a transmittal which have been reviewed and received "A" or "B" action in a prior submittal, will be returned with action "E. Engineer's Review Not Required."
10. Samples may be retained for comparison purposes.
 - a. Remove samples when directed.
 - b. Include in bid all costs of furnishing and removing samples.
11. Approved samples submitted or constructed, constitute criteria for judging completed work.
 - a. Finished work or items not equal to samples will be rejected.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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EXHIBIT A Shop Drawing Transmittal No.

(Spec Section) (Series)

Project Name:		Date Received:
Project Owner:		Checked By:
Contractor:	HDR Engineering, Inc.	Log Page:
Address:	Address:	HDR No.:
		Spec Section:
		Drawing/Detail No.:
Attn:	Attn:	1st. Sub ReSub.
Date Transmitted:	Previous Transmittal Date:	

Item No.	No. Copies	Description	Manufacturer	Mfr/Vendor Dwg or Data No.	Action Taken*

Remarks:

* The Action designated above is in accordance with the following legend:

A - Furnish as Submitted B - Furnish as Noted C - Revise and Submit 1. Not enough information for review. 2. No reproducibles submitted. 3. Copies illegible. 4. Not enough copies submitted. 5. Wrong sequence number. 6. Wrong resubmittal number. 7. Wrong spec. section. 8. Wrong form used. 9. See comments. D - Rejected	E - Engineer's review not required 1. Submittal not required. 2. Supplemental Information. Submittal retained for informational purposes only. 3. Information reviewed and approved on prior submittal. 4. See comments. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

Comments:

	By	Date

Distribution:	Contractor	File	Field	Owner	Other

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Contractor's Submittal Certification

Shop Drawing Transmittal No.:

Contract/Project Name:

Company Name:

has

1. reviewed and coordinated this Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
3. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

☐ This Submittal **does not** contain any variations from the requirements of the Contract Documents.

☐ This Submittal **does** contain variations from the requirements of the Contract Documents. A separate description of said variations and a justification for them is provided in an attachment hereto identified as:

"Shop Drawing Transmittal No. _____ Variation and Justification Documentation"

Insert picture file or electronic signature of Authorized
Representative

Authorized Representative

Date

SECTION 01 33 04
OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administration of the submittal process for Operation and Maintenance Manuals.
 - 2. Content requirements for Operation and Maintenance Manuals.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. General submittal requirements are specified in Specification Section 01 33 00 - Submittals.
 - 4. Technical Specification Sections identifying required Operation and Maintenance Manual submittals.

1.2 DEFINITIONS

- A. Equipment Operation and Maintenance Manuals:
 - 1. Contain the technical information required for proper installation, operation and maintenance of process, electrical and mechanical equipment and systems.
- B. Building Materials and Finishes Operation and Maintenance Manuals:
 - 1. Contain the information required for proper installation and maintenance of building materials and finishes.

1.3 SUBMITTALS

- A. List of all the Operation and Maintenance Manuals required by the Contract as identified in the Technical Specification Sections. These may be referred to as "Operation and Maintenance Data" submittals.
- B. Operation and Maintenance Manuals:
 - 1. Draft and final electronic copies.
 - 2. Final paper copies: One.

1.4 SUBMITTAL SCHEDULE

- A. List of Required Operation and Maintenance Manuals:
 - 1. Submit list with Specification Section number and title within 90 days after Notice to Proceed.
- B. Draft Operation and Maintenance Manuals:
 - 1. Submit approvable draft manuals in electronic format (PDF) within 30 days following approval of the respective Shop Drawing.
 - a. Include placeholders or fly sheet pages where information is not final or is missing from the draft manual.
 - 2. All Draft Operation and Maintenance Manuals shall be received by no later than 50 PCT project completion.
- C. Final Operation and Maintenance Manuals:
 - 1. Final approval of Operation and Maintenance Manuals in electronic format (PDF) must be obtained 45 days prior to equipment start-up.
 - 2. Provide paper copies and Electronic Documents (in portable document format, PDF files) by Electronic Means of approved final Operation and Maintenance Manuals in electronic format (PDF), a minimum of 30 days prior to equipment start-up.

3. Issue addenda to Final Approved Operation and Maintenance Manual to include:
 - a. Equipment data that requires collection after start-up, for example but not limited to HVAC balancing reports, electrical switchgear, automatic transfer switch and circuit breaker settings.
 - b. Equipment field testing data.
 - c. Equipment start-up reports.

1.5 PREPARATION OF SUBMITTALS

A. General:

1. All pages of the Operation and Maintenance Manual submittal shall be legible.
 - a. Submittals which, in the Engineer's sole opinion, are illegible will be rejected without review.
2. Identify each equipment item in a manner consistent with names and identification numbers used in the Contract Documents, not the manufacturer's catalog numbers.
3. Neatly type any data not furnished in printed form.
4. Operation and Maintenance Manuals are provided for Owner's use, to be reproduced and distributed as training and reference materials within Owner's organization.
 - a. This requirement is:
 - 1) Applicable to both paper copy and electronic files.
 - 2) Applicable to materials containing copyright notice as well as those with no copyright notice.
5. Notify supplier and/or manufacturer of the intended use of Operations and Maintenance Manuals provided under the Contract.

B. Operation and Maintenance Manual Format and Delivery:

1. Draft electronic submittals:
 - a. Provide manual in Adobe Acrobat Portable Document Format (PDF), latest version.
 - b. Create one (1) PDF file for each equipment Operation and Maintenance Manual.
 - c. Do not password protect or lock the PDF document.
 - d. Scanned images of paper documents are not acceptable. Create the Operation and Maintenance Manual PDF file from the original source document.
 - e. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
 - f. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 DPI or greater.
 - g. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
 - h. Create bookmarks in the bookmarks panel for the Operation and Maintenance Manual cover, the Table of Contents and each major section of the Table of Contents.
 - i. Using Adobe Acrobat Standard or Adobe Acrobat Professional, set the PDF document properties, initial view as follows:
 - 1) Select File → Properties → Initial View.
 - 2) Select the Navigation tab: Bookmarks Panel and Page.
 - 3) Select the Page layout: Single Page Continuous.
 - 4) Select the Magnification: Fit Page.
 - 5) Select Open to page: 1.
 - 6) Set the file to open to the cover page of the manual with bookmarks to the left, and the first bookmark linked to the cover page.
 - 7) Window Options: Check the "Resize window to initial page" box.
 - j. Set the PDF file "Fast Web View" option to open the first several pages of the document while the rest of the document continues to load.
 - 1) To do this:
 - a) Select Edit → Preferences → Documents → Save Settings.
 - b) Check the "Save As optimizes for Fast Web View" box.

- k. PDF file naming convention:
 - 1) Use the Specification Section number, the manufacturer's name and the equipment description, separated by underscores.
 - 2) Example: 46 51 21_Sanitaire_Coarse_Bubble_Diffusers.pdf.
 - 3) Do not put spaces in the file name.
 - 2. Final electronic submittals:
 - a. Submit two copies as Electronic Documents (in portable document format, PDF files) by Electronic Means (one copy per electronic media), each secured in a protective case.
 - b. Labeling:
 - 1) Provide the following printed labeling on all electronic media:
 - a) Project name.
 - b) Specification Section.
 - c) Equipment names and summary of tag(s) covered.
 - d) Manufacturer name.
 - e) Date (month, year).
 - c. Binding:
 - 1) Include labeled electronic media in a protective case.
 - a) Bind protective case in three-ring binder, inserted at the front of the Final paper copy submittal.
 - b) Protective case(s) to have means for securing electronic media to prevent loss (e.g., zip case, flap and strap, or equivalent).
 - 3. Final paper copy submittals:
 - a. Quantity: Provide two copies.
 - b. Paper: 8.5 x 11 IN or 11 x 17 IN bright white, 20 LB paper with standard three-hole punching.
 - c. 3-Ring Binder:
 - 1) Provide D-ring binder with clear vinyl sleeves (i.e. view binder) on front and spine.
 - 2) Insert binder title sheet with the following information under the front and spine sleeves:
 - a) Project name.
 - b) Specification Section.
 - c) Equipment names and summary of tag(s) covered.
 - d) Manufacturer name.
 - e) Date (month, year).
 - 3) Provide plastic sheet lifters prior to first page and following last page.
 - d. Drawings:
 - 1) Provide all drawings at 11 x 17 IN size, triple folded and three-hole punched for insertion into manual.
 - 2) Where reduction is not practical to ensure readability, fold larger drawings separately and place in three-hole punched vinyl envelopes inserted into the binder.
 - 3) Identify vinyl envelopes with drawing numbers.
 - e. Use plastic coated dividers to tab each section of each manual in accordance with the Table of Contents.
- C. Equipment Operation and Maintenance Manual Content:
 - 1. Provide a cover page as the first page of each manual with the following information:
 - a. Manufacturer(s) Name and Contact Information.
 - b. Vendor's Name and Contact Information.
 - c. Date (month, year).
 - d. Project Owner and Project Name.
 - e. Specification Section.
 - f. Project Equipment Tag Numbers.
 - g. Model Numbers.
 - h. Engineer's Name.
 - i. Contractor's Name.
 - 2. Provide a Table of Contents for each manual.

3. Provide Equipment Record sheets as follows:
 - a. Printed copies of the Equipment Record (Exhibits B1, B2 and B3), as the first tab following the Table of Contents.
 - 1) For Instrumentation and Control equipment, International Society of Automation (ISA) Data Sheets will be acceptable in lieu of the Equipment Record sheets.
 - b. Exhibits B1-B3 are available as Fillable PDF Form documents from the Engineer.
 - c. Each section of the Equipment Record must be completed in detail; simply referencing the related equipment Operation and Maintenance Manual sections for nameplate, maintenance, spare parts or lubricant information is not acceptable.
 - d. For equipment involving separate components (for example, a motor and gearbox), a fully completed Equipment Record is required for each component.
 - e. Submittals that do not include the Equipment Record(s) will be rejected without further content review.
 4. Provide a printed copy of the Manufacturer's Field Services report as required by Specification Section 01 75 00 following the Equipment Record sheets.
 5. Provide the following detailed information, as applicable:
 - a. Use equipment tag numbers from the Contract Documents to identify equipment and system components.
 - b. Equipment function, normal and limiting operating characteristics.
 - c. Instructions for assembly, disassembly, installation, alignment, adjustment, and inspection.
 - d. Operating instructions for start-up, normal operation, control, shutdown, and emergency conditions.
 - e. Maintenance instructions, including lubrication instructions if applicable
 - f. Troubleshooting guide.
 - g. Mark each sheet to clearly identify specific products and component parts and data applicable to the installation for the Project; delete or cross out information that does not specifically apply to the Project.
 - h. Parts lists:
 - 1) A parts list and identification number of each component part of the equipment.
 - 2) Exploded view or plan and section views of the equipment with a detailed parts callout matching the parts list.
 - 3) A list of recommended spare parts.
 - 4) List of spare parts provided as specified in the associated Specification Section.
 - 5) A list of any special storage precautions which may be required for all spare parts.
 - i. General arrangement, cross-section, and assembly drawings.
 - j. Electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, and interconnection diagrams.
 - k. Factory and field test data and performance curves (if applicable).
 - l. As-constructed fabrication or layout drawings and wiring diagrams.
 - m. Copy of the equipment manufacturer's warranty meeting the requirements of the Contract.
 - n. Copy of any service contracts provided for the specific piece of equipment as part of the Contract.
 6. Additional information as required in the associated equipment or system Specification Section.
 7. Include in Submittal the final, configured control setpoints and similar configurable parameters provided in the equipment.
- D. Building Materials and Finishes Operation and Maintenance Manual Content:
1. Provide a cover page as the first page of each manual with the following information:
 - a. Manufacturer(s) Name and Contact Information.
 - b. Vendor's Name and Contact Information.
 - c. Date (month, year).
 - d. Project Owner and Project Name.
 - e. Specification Section.

- f. Model Numbers.
 - g. Engineer's Name.
 - h. Contractor's Name.
- 2. Provide a Table of Contents for each manual.
- 3. Building products, applied materials and finishes:
 - a. Include product data, with catalog number, size, composition and color and texture designations.
 - b. Provide information for ordering custom manufactured products.
- 4. Necessary precautions:
 - a. Include product MSDS for each approved product.
 - b. Include any precautionary application and storage guidelines.
- 5. Instructions for care and maintenance:
 - a. Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
- 6. Moisture protection and weather exposed products:
 - a. Include product data listing, applicable reference standards, chemical composition, and details of installation.
 - b. Provide recommendations for inspections, maintenance and repair.
- 7. Additional requirements as specified in individual product specifications.
- E. National Fire Protection Association 70 (National Electrical Code) Documentation:
 - 1. Assemble documented calculations of Arc-Fault Current, Equipment Available Fault Current and Short Circuit Current Rating (SCCR) provided as part of equipment submittals into one O&M manual volume.

1.6 TRANSMITTAL OF SUBMITTALS

- A. Operation and Maintenance Manuals.
 - 1. Transmit all submittals to:
 - a. The address specified in Specification Section 01 33 00 - SUBMITTALS.
 - 2. Transmittal form: Use Operation and Maintenance Manual Transmittal, Exhibit A.
 - 3. Transmittal numbering:
 - a. Number each submittal with the Specification Section number followed by a series number beginning with "-01" and increasing sequentially with each additional transmittal, followed by "-OM" (for example: 43 23 14-01-OM).
 - 4. Submit draft and final Operation and Maintenance Manual in electronic format (PDF) to Engineer, until manual is approved.

1.7 ENGINEER'S REVIEW ACTION

- A. Draft Electronic (PDF) Submittals:
 - 1. Engineer will review and indicate one of the following review actions:
 - a. A - ACCEPTABLE
 - b. B - FURNISH AS NOTED
 - c. C - REVISE AND RESUBMIT
 - d. D - REJECTED
 - 2. Submittals marked as Acceptable or Furnish As Noted will be retained; however, the transmittal form will be returned with a request for the final paper and electronic documents to be submitted.
 - 3. Copies of submittals marked as Revise and Resubmit or Rejected will be returned with the transmittal form marked to indicate deficient areas.
 - 4. Resubmit until approved.
- B. Final Paper Copy Submittals:
 - 1. Engineer will review and indicate one of the following review actions:
 - a. A - ACCEPTABLE
 - b. D - REJECTED

2. Submittals marked as Acceptable will be retained with the transmittal form returned as noted.
3. Submittals marked as Rejected will be returned with the transmittal form marked to indicate deficient areas.
4. Resubmit until approved.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION



EXHIBIT A **Operation and Maintenance Manual**
Transmittal _____ - _____ - OM
(Spec Section) (Series) _____.

Project Name:		Date Received:
Project Owner:		Checked By:
Contractor:	Owner:	Log Page:
Address:	Address:	HDR No.:
Attn:	Attn:	1st. Sub. ReSub.

Date Transmitted:		Previous Transmittal Date:		
No.	Description of Item	Manufacturer	Dwg. or Data No.	Action Taken*
Copies				

Remarks:

To:	From:
	HDR Engineering, Inc.
	Date:

* The Action designated above is in accordance with the following legend:

A - Acceptable, provide one (1) additional paper copy and two (2) Electronic Documents (in portable document format, PDF files) by Electronic Means for final review.

B - Furnish as Noted

C - Revise and Resubmit

This Operation and Maintenance Manual Submittal is deficient in the following area:

1. Equipment Records.
2. Functional description.
3. Assembly, disassembly, installation, alignment, adjustment & checkout instructions.
4. Operating instructions.

5. Lubrication & maintenance instructions.
6. Troubleshooting guide.
7. Parts list and ordering instructions.
8. Organization (binder, binder titles, index & tabbing).
9. Wiring diagrams & schematics specific to installation.
10. Outline, cross section & assembly diagrams.
11. Test data & performance curves.
12. Tag or equipment identification numbers.
13. Inclusion of all components & subcomponents.
14. Other - see comments.

D - Rejected

Comments:

		By		Date	
Distribution:	Contractor	File	Field	Owner	Other

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EXHIBIT B1

Equipment Record

Equipment Data and Spare Parts Summary

Project Name					Specification Section:				
Equipment Name					Year Installed:				
Project Equipment Tag No(s).									
Equipment Manufacturer					Project/Order No.				
Address					Phone				
Fax			Web Site			E-mail			
Local Vendor/Service Center									
Address					Phone				
Fax			Web Site			E-mail			
MECHANICAL NAMEPLATE DATA									
Equip.					Serial No.				
Make					Model No.				
ID No.	Frame No.		HP		RPM		Cap.		
Size	TDH		Imp. Sz.		CFM		PSI		
Other:									
ELECTRICAL NAMEPLATE DATA									
Equip.					Serial No.				
Make					Model No.				
ID No.	Frame No.	HP	V.	Amp.	HZ	PH	RPM	SF	
Duty	Code	Ins. Cl.	Type	NEMA	C Amb.	Temp. Rise	Rating		
Other:									
SPARE PARTS PROVIDED PER CONTRACT									
Part No.		Part Name						Quantity	
RECOMMENDED SPARE PARTS									
Part No.		Part Name						Quantity	

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EXHIBIT B2

Equipment Record

Recommended Maintenance Summary

Equipment Description	Project Equip. Tag No(s).							
RECOMMENDED BREAK-IN MAINTENANCE (FIRST OIL CHANGES, ETC.)	INITIAL COMPLETION * FOLLOWING START-UP							
	D	W	M	Q	S	A	RT	Hours
RECOMMENDED PREVENTIVE MAINTENANCE	PM TASK INTERVAL *							
	D	W	M	Q	S	A	RT	Hours

* D = Daily W = Weekly M = Monthly Q = Quarterly S = Semiannual A = Annual Hours = Run Time Interval

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EXHIBIT B3

Equipment Record

Lubrication Summary

Equipment Description		Project Equip. Tag No(s).				
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					

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SECTION 01 45 00

QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Provisions followed by an asterisk (*) include some or all provision as obtained from AIA Document A201- General Conditions of the Contract for Construction.

1.2 SECTION INCLUDES

- A. Quality assurance and control.
- B. Regulatory requirements.
- C. Tolerances.
- D. Mock-ups.
- E. Manufacturer's field services.

1.3 QUALITY ASSURANCE AND CONTROL

- A. Monitor quality assurance and control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- D. Comply with specified standards as minimum quality for Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have Work performed by persons qualified and experienced to produce required or specified quality.
- F. Verify that field measurements are as indicated on approved shop drawings or as instructed by manufacturer of product.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.
- H. Materials shall be compatible with one another and with other materials with which they may come in contact.

1.4 SUPERVISION AND CONSTRUCTION PROCEDURES

- A. Contractor shall supervise and direct Work, using Contractor's best skill and attention. *
- B. Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences and procedures and for coordinating all portions of Work under the Contract, unless Contract Documents give other specific instructions concerning these matters. *
- C. Whether or not Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor shall review, substantiate, and comply with current industry execution standards and manufacturer's current execution instructions and evaluate jobsite safety thereof and shall be fully and solely responsible for jobsite safety of such means, methods, techniques, sequences or procedures. *
 - 1. If Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely written notice to Owner and Architect and

shall not proceed with that portion of Work without further written instructions from Architect. *

2. If Contractor is then instructed to proceed with the required means, methods, techniques, sequences or procedures without acceptance of changes proposed by Contractor, the Owner shall be solely responsible for any loss or damage arising solely from those Owner-required means, methods, techniques, sequences or procedures. *
- D. Contractor shall be responsible to Owner for acts and omissions of Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of Work for, or on behalf of Contractor or any of its Subcontractors. *
- E. Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work. *
- F. Contractor is solely responsible for coordination of scope of Work for its own forces, and of Subcontractors and suppliers, and to complete all Work, whether performed by the Contractor or a Subcontractor.
- G. Contractor shall employ Licensed Surveyor to locate and stake out Work and establish necessary reference and benchmarks.
 1. Work from established benchmarks and reference points, layout and correctly establish lines, levels, grades, and locations of all parts of their own Work and be responsible for their accuracy and proper correlation with Work and established data.

1.5 REGULATORY REQUIREMENTS

- A. Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of Work. *
- B. If Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction, including, but not limited to, any penalties, fines or other damages realized. *
- C. When Contract Documents require Contractor, Subcontractor, Vendor or other supplier to provide selection or design of parts of Work, such selection or design shall meet requirements of Municipal, State or other governmental authorities having jurisdiction.

1.6 TOLERANCES

- A. Monitor fabrication and installation tolerance control of Products to produce approved Work.
 1. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances.
 1. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
- C. Adjust Products to appropriate dimensions; position before securing Products in place.

1.7 MANUFACTURER'S FIELD SERVICES AND REPORTS

- A. When field services are specified, have material or product suppliers, or manufacturers, provide technically competent staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and supervise installation where specified, as applicable and to initiate instructions when necessary.
- B. Report observations, and site decisions or instructions given to applicators or installers which are supplemental or contrary to manufacturer's written instructions.
- C. Submit report in duplicate within 30 days of observation.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent work. Beginning new work means acceptance of existing conditions.
- B. Verify existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual Specification Sections.
- D. Verify that utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

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SECTION 01 45 23
TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. General:

1. Work shall be subject to inspection, testing and approval by testing agency, inspector and building official, or public authorities having jurisdiction.
2. Approval as result of inspection or testing shall not be construed to be an approval of a violation of provisions of Contract Documents, or by governing codes, laws, ordinances, rules or regulations.
3. Testing, inspections and approvals presuming to give authority to violate or cancel provisions of Contract Documents, or by governing codes, laws, ordinances, rules or regulations shall not be valid.
4. It shall be duty of Contractor to cause Work to remain accessible and exposed for testing and inspection purposes.
5. It shall be duty of Contractor to notify testing agency, inspector and building official or public authorities having jurisdiction when Work is in conformance with Contract Documents and is ready for testing and inspection.
6. It shall be duty of Owner and Contractor to provide access to, and means for testing and inspections of such Work required by Contract Documents, or by governing codes, laws, ordinances, rules or regulations.
7. Any portion that does not comply shall be corrected and shall not be covered or concealed until authorized by testing agency, inspector and public authorities having jurisdiction.
8. Tests, inspections and approvals of portions of Work required by Contract Documents or by codes, laws, ordinances, rules, regulations or orders of building official or public authorities having jurisdiction shall be made at an appropriate time.
9. Contractor shall give testing agency, inspector, building official or public authorities having jurisdiction, and Architect, if requested, timely notice of when and where tests and inspections are to be made so that they may be present for such procedures.
10. In event such procedures for testing, inspection and approval reveal portions of Work fail to comply with requirements established by Contract Documents, or by governing codes, laws, ordinances, rules or regulations, costs made necessary by such failure, including those of repeated procedures and compensation for Architect's services and expenses, shall be at Contractor's expense.
11. Required certificates of testing, inspection and approval shall, unless otherwise required by Contract Documents, be secured by Contractor and promptly delivered to Architect, inspector, building official and public authorities having jurisdiction.
12. If Architect, Owner, building official, public authorities having jurisdiction, testing agency or inspector is to observe tests, inspections and approvals required by Contract Documents, or by governing codes, laws, ordinances, rules or regulations or orders of building official or public authorities having jurisdiction, they will do so promptly, and where practicable, at normal place of testing.
13. Construction or Work for which a building permit is required shall be subject to inspections by building officials and such construction or Work shall remain accessible and exposed for inspection purposes until approved.
 - a. Building officials is authorized to accept reports of approved inspection agencies, provided such agencies satisfy requirements as to qualifications and reliability.
 - b. See governing codes, laws, ordinances, rules and regulations for additional requirements.

- B. Test and inspection method standards: See technical sections and governing codes, laws, ordinances, rules and regulations.

- C. Qualifications of independent testing agencies:
1. Testing agency shall comply with governing codes, laws, ordinances, rules and regulations.
 - a. Testing agency shall provide information necessary for building official to determine that testing agency meets applicable requirements.
 - b. Testing agency shall be objective, competent and independent from Contractor responsibility for Work being inspected.
 - c. Agency shall disclose possible conflicts of interest so that objectivity can be confirmed.
 - d. Agency shall have adequate equipment to perform required tests, and equipment shall be periodically calibrated.
 - e. Agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and/or inspections.
 - f. See governing codes, laws, ordinances, rules and regulations for additional requirements.
 2. Meet American Council of Independent Laboratories, Recommended Requirements of Independent Laboratory Qualification, latest edition.
 3. Meet requirements of ASTM E329, Standards of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as used in Construction, latest edition.
 4. Meet requirements of AASHTO Materials Reference Library (AMRL) R18 Standard Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories.
 5. Meet requirements of ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories.
 6. Satisfy inspection criteria of Materials Reference Laboratory of National Institute of Standards and Technology.
 7. See technical sections for additional requirements.
- D. Testing equipment calibration shall be by accredited calibration agency, at maximum 12 month intervals, by devices of accuracy traceable to either:
1. National Institute of Standards and Technology.
- E. Special Inspections:
1. Owner will employ one or more special inspectors to perform inspections during construction on types of Work required by governing codes.
 - a. These inspections are in addition to inspections by building officials having jurisdiction.
 - b. See governing codes, laws, ordinances, rules and regulations for additional requirements.
- F. Structural Observations:
1. Owner will employ a registered design professional to perform structural observations as defined in the governing codes where required by provisions of governing codes.
 - a. See governing codes, laws, ordinances, rules and regulations for additional requirements.

1.2 DESCRIPTION

- A. Owner will arrange and pay for following testing and inspections performed by testing agency or special inspector:
1. Soil compaction inspection and testing: Section 31 23 00.
 2. Excavation inspection: Section 31 23 00.
 3. Concrete floor finish tolerance testing: Section 03 35 00.
 4. Architectural Precast Concrete: Section 03 45 00.
 5. Masonry accessory installation inspection: Section 04 05 23.
 6. Concrete masonry inspection: Section 04 22 00.
 7. Roof deck: Section 05 31 23.
 8. Owner shall bear costs of tests, inspections or approvals which do not become requirements until after bids are received or negotiations concluded.

9. Testing and balancing mechanical systems: Section 23 08 00.
- B. Contractor arrange and bear related costs for following tests, inspections and approvals with an independent testing agency or entity acceptable to Owner:
 1. Radiation Shielding: Section 09 29 00.
 2. 3Rebar locating for drilling, core drilling or cutting of concrete.
 3. Testing and inspections of Contractor provided shoring or forming.
 4. Additional inspection and testing required by public authorities having jurisdiction.
 5. Contractor's duties for Owner provided tests, as specified.
- C. Contractor shall arrange for, and bear related costs for following with Owner provided independent testing agency or entity acceptable to Owner:
 1. Re-testing due to failure of initial test or due to nonconformance with Contract Documents.
 2. Re-inspections of Work due to failure of Work to pass initial inspection or due to nonconformance with Contract Documents.

1.3 JOB CONDITIONS

- A. Employment of independent testing agency does not relieve Contractor of obligation to comply with Contract Documents.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. Perform indicated inspections, sampling and testing of materials and methods of construction.
- B. Use test and inspection or sampling methods or both conforming with methods indicated.
- C. Report each test and inspection or sampling or both as indicated.
- D. Report results called for by test method, in form specified.
- E. Retest failed products and systems.

3.2 REPORTS

- A. Submit reports and logs promptly to Architect, Structural Engineer, Contractor, inspector, and public authorities having jurisdiction.
- B. Include following for test or inspection reports or both:
 1. Project name and number.
 2. Project location.
 3. Product and specification section applicable.
 4. Type of test or inspection or both.
 5. Name of testing agency, if used.
 6. Name of testing or inspecting personnel, or both.
 7. Date of test or inspection or both.
 8. Record of field conditions encountered; i.e., temperature, weather.
 9. Test location.
 10. Observations regarding compliance.
 11. Test method used.
 12. Results of test.
 13. Date of report.
 14. Signature of testing or inspecting personnel or both.
- C. Maintain log of tests which have failed:
 1. Type of test or inspection or both.
 2. Date of test or inspection or both.

3. Test or inspection number or both.
4. Reason failed.
5. Date of retest or inspection or both.
6. Results of retest.
7. Method of retest.

3.3 INDEPENDENT TESTING AGENCY DUTIES AND LIMITATIONS OF AUTHORITY

- A. Cooperate with Architect and Contractor.
- B. Provide qualified personnel promptly on notice.
- C. Promptly notify Architect and Contractor of irregularities, or deficiencies of work which are observed during performance of services.
- D. Testing agency is not authorized to:
 1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Approve or accept any portion of Work.
 3. Perform any duties of Contractor.

3.4 CONTRACTOR'S DUTIES

- A. Cooperate with testing agency personnel, inspector and public authorities having jurisdiction and provide access to work.
- B. Provide preliminary representative samples of materials to be tested, in required quantities.
- C. Furnish copies of mill test reports.
- D. Furnish labor and facilities:
 1. To provide access to work to be tested.
 2. To obtain and handle samples at site.
 3. To facilitate inspections and tests.
 4. Storage and curing facilities for testing agency's exclusive use.
- E. Notify building official and testing agencies when Work is ready for inspections.
- F. Construction or Work for which Special Inspections are required shall remain accessible and exposed for special inspections purposes until completion of required special inspections.
- G. Provide access to and means for inspections by building officials and testing agencies of such Work that are required.
- H. Work shall not be done beyond point indicated in each successive inspection without first obtaining approval of building official.
- I. Any portion of Work that does not comply shall be corrected and such portions shall not be covered or concealed until authorized by building official.
- J. Notify appropriate testing agency, inspector or public authorities having jurisdiction sufficiently in advance of operations.

END OF SECTION

SECTION 01 61 00

COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Performance of product, material, or system is result of manufacturing, fabrication, installation procedures, use, and maintenance:
 - 1. Therefore, Architect endeavors to specify quality levels for products, materials, or systems that are advertised to conceptually meet performance goals and desired attributes for Project.
 - a. For most conceptually equal systems and materials, the Architect may specify multiple manufactures.
 - b. In some cases, based on quality and attribute goals for Project, number of manufacturers may be limited.

1.2 SPECIFYING METHODS AND PRODUCT OPTIONS

- A. Method 1: Products are specified by naming two or more manufacturers. Substitutions are not permitted. Any one of manufacturers named may be used that meet specified requirements.
- B. Method 2: Products are specified by naming one or more manufacturers. Substitutions are permitted. Any one of manufacturers named may be used that meet specified requirements. Submit a substitution request for any manufacturer not specifically named.
- C. Method 3: Proprietary: No Substitutions. Products are specified by naming only one manufacturer.
- D. Method 4: “Base” and “Optional”.
 - 1. Base:
 - a. Manufacturer listed as Base in Part 2 of specification section.
 - b. Manufacturer listed as Base is particular manufacturer of a specific product used as basis of design.
 - 1) Products of the Base manufacturer are specific products, assemblies or systems used and identified with model numbers, dimensions or other identifying features.
 - 2. Optional:
 - a. Manufacturer listed as Optional in Part 2 of specification section.
 - b. More than one manufacturer may be listed as Optional.
 - c. Proposals may be based on any of the manufacturers listed.
 - d. Manufacturers listed as Optional are particular manufacturers of products similar to the specific product used as basis of design.
 - e. Optional products are without model numbers, dimensions or other identifying features.
 - f. Listing manufacturer as Optional indicates acceptance of that manufacturer as supplier of a product to extent product complies with specified descriptive requirements listed in technical specification, including salient qualities provided by Base manufacturer’s product.
 - 1) Salient qualities include, but are not necessarily limited to following:
 - a) Purpose and function.
 - b) Material and finish.
 - c) Strength, durability and other applicable physical properties.
 - d) Compatibility and performance attributes for indicated application.
 - e) Capacity and operating characteristics, where applicable.
 - f) Size and configuration to extent required for fit with adjoining and adjacent conditions and within spatial limitations.
 - g) Appearance, including exposed dimensions, profile, texture, pattern and color, where visible to personnel in finished space, or from exterior.

- 2) Optional Products that significantly differ in appearance or quality of Base product will not be accepted.
- g. Contractor is responsible for costs to provide dimensional, operational, structural, utility, or other related adjustments to fit an Optional manufacturer's product into Work.
- h. Submit Optional Manufacturer Product/System Comparison form with Bid for the Optional product.
 - 1) See Section 01 33 00, Submittal Procedures, for protocol and form.
- 3. Refer to specification sections for additional requirements.
- E. Method 5: Generic: Products are specified by reference standard, by performance, by description or by any combination of these three.
 - 1. Products meeting or exceeding specification requirements may be used.
 - 2. Contractor assumes responsibility for compatibility of products selected.
- F. Method 6: Visual Matching: Where specifications and drawings require matching existing materials or a sample, the Architect's decision on whether a proposed product matches is final. Where no product matches or complies with other requirements, comply with specified substitution requests and submittal procedures.

1.3 DEFINITIONS

- A. "Product" means material, machinery, components, equipment, fixtures and systems forming Work. The term does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.
- B. New Products: Items not previously incorporated into another project or facility, Products salvaged or recycled from other projects are not considered new products.

END OF SECTION

SECTION 01 61 03
EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.
- B. Related Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
 2. Division 01 - General Requirements.
 3. Section 03 15 19 - Anchorage to Concrete.
 4. Section 03 31 30 - Concrete, Materials and Proportioning.
 5. Section 05 50 00 - Metal Fabrications.
 6. Section 07 92 00 - Joint Sealants.
 7. Section 09 96 00 - High Performance Industrial Coatings.
 8. Section 10 14 00 - Identification Devices.
 9. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
 10. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
 11. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
1. American Bearing Manufacturers Association (ABMA).
 2. American Gear Manufacturers Association (AGMA).
 3. ASTM International (ASTM):
 - a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
 - b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 4. Hydraulic Institute (HI):
 - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 5. International Electrotechnical Commission (IEC).
 6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
 7. International Organization for Standardization (ISO):
 - a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
 - b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.
 8. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 6, Enclosures for Industrial Control and System.
 - c. MG 1, Motors and Generators.
 9. InterNational Electrical Testing Association (NETA):
 - a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
 10. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC):
 11. National Institute for Certification in Engineering Technologies (NICET).
 12. National Institute of Standards and Technology (NIST).
 13. Occupational Safety and Health Administration (OSHA):

- a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
 14. Underwriters Laboratories, Inc. (UL).
 - a. 508, Standard for Safety Industrial Control Equipment.
 - b. 508A, Standard for Safety Industrial Control Panels.
 - c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
 15. Vibration Institute.
- B. Supplier's Vibration Analyst:
1. Supplier's vibration analyst shall prepare pre-Shop Drawing vibration analysis of equipment.
 2. Where required, Supplier's vibration analyst shall be either equipment manufacturer's qualified employee or independent business entity whose sole business, or principal part of its business, is evaluating and determining natural frequencies of rotating equipment.
 3. Shall possess not less than 10 years' relevant experience.
 4. Supplier's Vibration Analyst's Professional Engineer:
 - a. Vibration analysis shall be performed by, or under the direct, personal supervision of, professional engineer licensed and registered in the same jurisdiction as the Site experienced in preparing finite element analyses, rotordynamic analyses, and experimental modal analysis similar to that required for the Work.
 - b. Professional engineer shall possess not less than five years' combined experience in field testing and data analysis for vibration analysis.
 - c. Vibration analysis professional engineer's seal and signature, with indication of date seal and signature were applied to the subject document, shall clearly appear on all results and reports furnished as Submittals.
- C. Field Vibration Testing Subcontractor:
1. Field vibration testing Subcontractor shall, where required by the Contract Documents, perform vibration testing of equipment installed at the Site and perform associated vibration analyses.
 2. Vibration testing Subcontractor shall be an independent entity that has performed as its sole business, or principal part of its business, for not less than 10 years, inspection, testing, calibrating, adjusting equipment and systems, and performing vibration testing of equipment.
 3. Entities whose principal business is one or more of the following are not considered independent vibration testing entities and, therefore, shall not be field vibration testing Subcontractor:
 - a. Motor sales, service, or repairs.
 - b. Process equipment sales, service, or repairs.
 4. Acceptable entities include, but are not necessarily limited to:
 - a. AVS Engineering: <https://www.avsengineering.net/>
 - b. Engineering Testing Services: <https://etestinc.com/>
 - c. Maritech, LLC: <http://www.maritech-llc.com/contact.html>
 - d. Or equal.
 5. Field vibration testing Subcontractor must have an established program for monitoring and testing equipment calibration, with accuracy traceable in an unbroken chain, in accordance with NIST requirements.
 6. Field Personnel: Each person employed for field vibration testing on the Work shall possess not less than the following qualifications:
 - a. Three years' field experience covering all phases of field vibration testing and data gathering.
 - b. Current, valid Vibration Category II certification from Vibration Institute or a licensed, registered professional engineer who need not be licensed and registered in the same jurisdiction as the Site.

7. Analysis Personnel: Personnel performing analysis for field vibration testing Subcontractor shall possess not less than the following qualifications:
 - a. Five years' combined field testing and data analysis experience.
 - b. Current, valid Vibration Category III certification from the Vibration Institute or a professional engineer licensed and registered in in the same jurisdiction as the Site. Where required by Laws and Regulations, field vibration analysis report shall be sealed, signed, and dated by professional engineer who personally prepared, or exercised personal, supervisory control over subordinates in preparing, the field vibration analysis report.
 8. Analysis Equipment: Field vibration testing Subcontractor shall have access to and use, where appropriate, the following testing equipment, properly maintained and calibrated:
 - a. Impact Hammer:
 - 1) Frequency Range: 1 kHz.
 - 2) Range (5v output) 5,000 pounds-force (22,200 newtons).
 - 3) Hammer sensitivity (approx.) 1mV/lbf (0.23 mV/N)
 - b. Analyzer:
 - 1) Frequency Range: 1 Hz to 10,000Hz.
 - 2) Frequency Accuracy: 0.02 percent.
 - 3) Non-Integrated Spectral Amplitude Accuracy: 5 percent, 3 Hz to 65 Hz.
 - 4) Single Integrated Spectral Amplitude Accuracy: 5 percent, 10 Hz to 20 Hz.
 - 5) Supports measurements of acceleration, velocity, and displacement.
 - c. Vibration Sensor:
 - 1) Sensitivity: ± 5 percent = 100 mV/g
 - 2) Acceleration Range: ± 5 g.
 - 3) Amplitude Nonlinearity: ± 1 percent
 - 4) Frequency Response: ± 10 Hz to 7kHz (± 3 dB)
 - d. Data logging equipment for simultaneous recording of the following data points:
 - 1) Vibration in the X, Y, and axial planes (for all pumps pursuant to ANSI/HI Standard).
 - 2) Digital tachometer recording RPM.
 - 3) Discharge Pressure Transmitter
 - a) Accuracy: 0.3 percent of range
 - b) Fluid Temperature Range: 32 to 100 DegF
 - 4) Suction Pressure Transmitter (when other than submersible pump or vertical turbine (suspended) pump.
 - a) Accuracy 0.35 percent of range.
 - b) Fluid Temperature Range: 32 to 100 DegF.
 - c) For submersible pumps and vertical turbine (suspended) type pumps, suction liquid surface level signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
 - 5) For pumps, pumping rate (flow) signal from Site's monitoring and control system (e.g., plant PLC/SCADA system)
 - 6) Equipment/motor bearing temperature signal from Site's monitoring and control system (e.g., plant PLC/SCADA system)).
 - 7) Pump/motor vibration signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
- D. Infrared Thermography Testing Program:
1. Testing firm:
 - a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
 - b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.

2. Field personnel:
 - a. Minimum of one year field experience covering all phases of field thermography testing and data gathering.
 - b. Supervisor certified by NETA or NICET.
 3. Analysis personnel:
 - a. Minimum three years combined field testing and data analysis experience.
 - b. Supervisor certified by NETA or NICET.
- E. Electrical Equipment and Connections Testing Program:
1. Testing firm:
 - a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
 - b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
 2. Field personnel:
 - a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
 - b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
 - c. Supervisor certified by NETA or NICET.
 3. Analysis personnel:
 - a. Minimum three years combined field testing and data analysis experience.
 - b. Supervisor certified by NETA or NICET.
- F. Miscellaneous:
1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
 - a. More than one manufacturer is listed for a given "product" in Specifications.
 - b. No manufacturer is listed.
 2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations shown on Electrical Power Drawings and defined in the Electrical specifications.
 3. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and verify their compatibility.

1.3 DEFINITIONS

- A. Product: Manufactured materials and equipment.
- B. Major Equipment Supports - Supports for Equipment:
1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;
 2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
 3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.
- C. Equipment:
1. One or more assemblies capable of performing a complete function.
 2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
 3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.
- D. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. General for all equipment:
 - a. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - b. Data sheets that include manufacturer's name and complete product model number.
 - 1) Clearly identify all optional accessories that are included.
 - c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
 - d. Manufacturer's delivery, storage, handling, and installation instructions.
 - e. Equipment identification utilizing numbering system and name utilized in Drawings.
 - f. Equipment installation details:
 - 1) Location of anchorage.
 - 2) Type, size, and materials of construction of anchorage.
 - 3) Anchorage setting templates.
 - 4) Manufacturer's installation instructions.
 - g. Equipment area classification rating.
 - h. Shipping and operating weight.
 - i. Equipment physical characteristics:
 - 1) Dimensions (both horizontal and vertical).
 - 2) Materials of construction and construction details.
 - j. Equipment factory primer and paint data.
 - k. Manufacturer's recommended spare parts list.
 - l. Equipment lining and coatings.
 - m. Equipment utility requirements include air, natural gas, electricity, and water.
 - n. Ladders and platforms provided with equipment:
 - 1) Certification that all components comply fully with OSHA requirements.
 - 2) Full details of construction/fabrication.
 - 3) Scaled plan and sections showing relationship to equipment.
2. Mechanical and process equipment:
 - a. Operating characteristics:
 - 1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
 - 2) Brake horsepower requirements.
 - 3) Copies of equipment data plates.
 - b. Piping and duct connection size, type and location.
 - c. Equipment bearing life certification.
 - d. Equipment foundation data:
 - 1) Equipment center of gravity.
 - 2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
3. Electric motor:
 - a. Motor manufacturer and model number.
 - b. Complete motor nameplate data.
 - c. Weight.
 - d. NEMA design type.
 - e. Enclosure type.
 - f. Frame size.
 - g. Winding insulation class and temperature rise.
 - h. Starts per hour.
 - i. Performance data:
 - 1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage.

- 2) Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage.
 - 3) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load.
 - 4) Guaranteed minimum power factor at 100 percent, 75 percent, and 50 percent of full load.
 - 5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
 - 6) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
 - j. Bearing data and lubrication system.
 - k. Natural frequency calculations for:
 - 1) Completed assembly including but not limited to the equipment base, rotating piece of equipment, and the rotating piece of equipment driver.
 - 2) Individual piece of rotating equipment.
 - 3) Equipment driver and connected gear reducer, if applicable.
 - l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.
 - m. [Maximum permissible capacitor (kVAC) that can be connected to the motor.]
 - n. [Recommended size of power factor correction capacitors to improve power factor to 0.95 lagging when operated at full load.]
 - o. Fabrication and/or layout drawings:
 - 1) Dimensioned outlined drawing.
 - 2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
 - p. Certifications:
 - 1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
 - 2) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
 - a) Include minimum speed at which the motor may be operated for the driven machinery.
 - q. Electrical gear:
 - 1) Unless specified in a narrow-scope Specification Section, provide the following:
 - a) Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
 - 2) Control panels:
 - a) Panel construction.
 - b) Point-to-point ladder diagrams.
 - c) Scaled panel face and subpanel layout.
 - d) Technical product data on panel components.
 - e) Panel and subpanel dimensions and weights.
 - f) Panel access openings.
 - g) Nameplate schedule.
 - h) Panel anchorage.
 - i) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70.
4. Systems schematics and data:
- a. Provide system schematics where required in system specifications.
 - 1) Acknowledge all system components being supplied as part of the system.
 - 2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
 - 3) Provide technical data for each system component showing compliance with the Contract Document requirements.
 - 4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.

5. For factory painted equipment, provide paint submittals in accordance with Section 09 96 00.
 6. Qualifications for:
 - a. Natural frequency analysis firm and personnel.
 - b. Vibration testing firm and personnel.
 - c. Infrared thermography testing firm and personnel.
 - d. Electrical equipment and connections testing firm and personnel.
 7. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:
 - a. Natural frequency analysis and calculations.
 - b. Vibration testing.
 - c. Thermography testing.
 - d. Electrical equipment and connection testing.
- B. Factory Test Reports:
1. Natural frequency bump test reports where required for rotating equipment.
 - a. Minimum characteristics of impact hammer.
 - 1) Frequency Range 1 kHz.
 - 2) Range (5v output) 5,000 LBF (22,200 N).
 - 3) Hammer Sensitivity (7pprox.) 1 mV/lbf (0.23 mV/N).
 - 4) Resonant Frequency 12 kHz
 2. Motor, equipment and final assembled equipment including motor.
 - a. Determine natural frequency of assembled motor prior to shipping to equipment manufacturer or job site.
 - 1) Individual motor fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.
 - b. Determine natural frequency of the pump.
 - 1) Pump fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.
 - c. Determine natural frequency of the pump/motor assembly.
 - 1) Pump/motor assembly fastened to an "infinitely rigid" mass at the same bolt circle as the final field assembled equipment.
 - d. For this use, the "infinitely rigid" mass shall be at least 10 times the weight of the equipment being tested.
 3. Submit natural frequency report(s) for approval prior to shipment.
 4. Equipment performance tests.
 - a. As listed in individual equipment specifications.
- C. Contract Closeout Information:
1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- D. Informational Submittals:
1. Notification, at least one week in advance, that testing will be conducted at factory.
 2. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
 3. Submit sample Manufacturer's Field Service Report (MFSR). Report shall use manufacturer's standard report or use the form in the Exhibits and have at least the following information:
 - a. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
 - b. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.

- c. Motor test reports.
 - d. Field noise testing reports if such testing is specified.
 - e. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
 - f. Provide three bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
 - 1) Include the acceptance criteria of all equipment tested.
 - 2) Provide individual tabbed sections for information associated with each piece of tested equipment.
 - g. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
 - h. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
 - i. Certification that driven equipment and VFD are compatible.
4. Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
- 1. Motors:
 - a. Baldor.
 - b. General Electric.
 - c. Hyundai Heavy Industries.
 - d. Marathon Electric.
 - e. Rockwell - Reliance.
 - f. Siemens.
 - g. TECO-Westinghouse.
 - h. Toshiba U.S.
 - i. U.S. Motors, Nidec Motor Corporation.
 - j. WEG.
 - 2. Mechanical variable speed drives:
 - a. Reeves.
 - b. U.S. Motors (VariDrive).
- B. Submit request for substitution in accordance with Section 01 25 00.

2.2 MANUFACTURED UNITS

- A. Electric Motors:
- 1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
 - 2. Design for frequent starting duty equivalent to duty service required by driven equipment.
 - 3. Design for full voltage starting.
 - 4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
 - 5. Size for altitude of Project.
 - 6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
 - 7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
 - 8. AC electric motors less than 1/3 HP:
 - a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.

- b. Permanently lubricated sealed bearings conforming to ABMA standards.
 - c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
- 9. AC electric motors 1/3 to 1 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - b. Permanently lubricated sealed bearings conforming to ABMA standards.
 - 1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
- 10. AC electric motors 1-1/2 to 10 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - b. Permanently lubricated sealed bearings conforming to ABMA standards.
 - c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
- 11. AC electric motors greater than 10 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
 - 1) Design bearing life for 90 percent survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
 - 2) For motors greater than 100 HP, design bearing life for 90 percent survival rating at 100,000 HRS of operation.
 - c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
 - d. Thermal protection:
 - 1) For motors 50 HP and above controlled from a variable frequency drive and for all other motors 100 HP and above, provide integral thermal detectors with normally closed contacts that will open on overtemperature or resistance type temperature detector (RTD) complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.
 - a) Two thermal sensing devices per phase in each phase hot-spot location.
 - b) Monitor and alarm panel:
 - (1) For constant speed motors, install panel in and energize from the motor starter equipment.
 - (2) For variable speed motors, install panel in and energize from the variable speed drive equipment.
- 12. Severe duty motor to have the following minimum features:
 - a. All cast iron construction.
 - b. Gasketed conduit box.
 - c. Epoxy finish for corrosion protection.
 - d. Hydroscopic varnish on windings for corrosion protection.
 - e. Drain plug and breather.
- B. NEMA Design Squirrel Cage Induction Motors:
 - 1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
 - 2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
 - 3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
 - 4. For use on variable frequency type adjustable speed drives, provide:
 - a. Induction motors that are in compliance with NEMA MG 1, Part 31.
 - b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
 - c. Insulated drive end bearing on all motors.
 - d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
 - e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.

- f. Shaft grounding ring on all motors:
 - 1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
 - 2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
 - g. Have the following minimum turndown ratio without the use of additional cooling, such as a blower, to provide continuous supply of cooling air over the motor.
 - 1) Variable torque: 10:1.
 - 2) Constant torque: 6:1.
- 5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DEGC ambient.
- 6. Design motors for continuous duty.
- 7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.
 - a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.
- 8. Motor enclosure and winding insulation application:
 - a. The following shall apply unless modified by specific Specification Sections:
- 9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
- 10. Balance motors to ISO G2.5 level.
 - a. Submit prior to shipping to equipment manufacturer or job site.
- C. Submersible Motors: Refer to individual narrow-scope Specification Sections for submersible motor requirements.
- D. V-Belt Drive:
 - 1. Provide each V-belt drive with sliding base or other suitable tension adjustment.
 - 2. Provide V-belt drives with a service factor of at least 1.6 at maximum speed.
 - 3. Provide staticproof belts.
- E. Mechanical Variable Speed Drives:
 - 1. Oil-lubricated shaft-mounted reduction gear drive capable of 300 percent shock load and providing a 1.5 service factor in accordance with AGMA.
 - 2. Secure drive to equipment base.
 - 3. Flexible coupling between drive shaft and equipment shaft.
- F. Vibration Isolators:
 - 1. Provide all equipment subject to vibration with restrained spring type vibration isolators or pads according to the manufacturer's written recommendation.
- G. Space Heaters:
 - 1. Silicone rubber strip type, 120 V rated.
 - 2. Provided on:
 - a. All motors 10 HP and larger mounted outdoors.
 - b. Indoor motors in humid environments as indicated.

2.3 COMPONENTS

- A. Gear Drives and Drive Components:
 - 1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
 - 2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
 - 3. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.

4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
5. Gear reducers:
 - a. Provide gear reducer totally enclosed and oil lubricated.
 - b. Utilize antifriction bearings throughout.
 - c. Provide worm gear reducers having a service factor of at least 1.20.
 - d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

2.4 ACCESSORIES

- A. Guards:
 1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
 2. Interior applications:
 - a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
 - b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
 - c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
 3. Exterior applications:
 - a. Construct from 16 GA stainless steel or aluminum.
 - b. Construct to preclude entrance of rain, snow, or moisture.
 - c. Roll to conform to shaft or coupling surface.
 - d. Connect to equipment frame with stainless steel bolts and wing nuts.
- B. Anchorage:
 1. Cast-in-place anchorage:
 - a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
 - b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
 - c. Provide two nuts for each bolt.
 2. Drilled anchorage:
 - a. Adhesive anchors per Section 03 15 19.
 - b. Epoxy grout per Section 03 31 30.
 - c. Threaded rods same as cast-in-place.
- C. Data Plate:
 1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
 2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.
- D. Gages:
 1. Provide at the following locations:
 - a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
 - b. At locations identified on Drawings.
 2. Utilize tapping sleeves for mounting per Section 40 05 00.
- E. Lifting Eye Bolts or Lugs:
 1. Provide on all equipment 50 LBS or greater.
 2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.
- F. Platforms and Ladders:
 1. Design and fabricate in accordance with OSHA Standards.
 2. Fabricate components from material indicated in the contract drawings. .
 3. Provide platform surface: Non-skid grating, unless specified in narrow-scope Specification Sections.

2.5 FABRICATION

- A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.
- B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.
- C. Furnish like parts of duplicate units to be interchangeable.
- D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.
- E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
 - 1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.
- F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
 - 1. Provide drain connection for 3/4 IN PVC tubing.
- G. Machine the mounting feet of rotating equipment.
- H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.
 - 1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
 - 2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07 92 00.
- I. Natural frequency/critical Speed:
 - 1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
 - 2. Excessive vibration is sufficient cause for equipment rejection.
 - 3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.
- J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
 - 1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.
 - 2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
 - 3. Affix entire assembly with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to delivery.
 - a. Control panels without an affixed UL 508A or UL 698A label shall be rejected.
 - 4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - a. Determine the SCCR rating by one of the following methods:
 - 1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - 2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - 3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.

- c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

2.6 SHOP OR FACTORY PAINT FINISHES

- A. Electrical Equipment:
 1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Section 09 96 00 to receive field painting.
 - a. Field painted equipment: See Section 09 96 00 for factory applied primer/field paint compatibility requirements.
- B. Field paint other equipment in accordance with Section 09 96 00.
 1. See Section 09 96 00 for factory applied primer/field paint compatibility requirements.

2.7 SOURCE QUALITY CONTROL

- A. Motor Tests:
 1. Test motors in accordance with NEMA and IEEE standards.
 2. Provide routine test for all motors.
 3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
 - a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
 - b. Pay all costs, including shipping and handling, for all motors failing the tests.
 - c. If two successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.
- B. Balance:
 1. Unless specified otherwise, for all equipment 10 HP or greater, all rotating elements in motors, pumps, blowers, and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. Balance all rotating elements to the following criteria, per ISO 21940-11:

$$U_{per} = \frac{G \times 6.015 \times W/2}{N}$$

Where:

U_{per} = Permissible residual unbalance for each correction plane in ounce-inches (OZ-IN). See ISO 21940-11 for acceptable values.

G = ISO Balance Quality Grade Number, per ISO 21940-11

W = Rotor weight in pounds

N = Maximum continuous operating RPM

- a. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.
- B. Utilize templates for anchorage placement for slab-mounted equipment.
- C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
 1. Route clear of major traffic areas and as approved by Engineer.
- D. DO NOT construct foundations until major equipment supports are approved.

- E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.
- F. Equipment Base:
 1. Construct level in both directions.
 2. Take particular care at anchor bolt locations so these areas are flat and level.
- G. Machine Base:
 1. Mount machine base of rotating equipment on equipment base.
 - a. Level in both directions, using a machinist level, according to machined surfaces on base.
 2. Level machine base on equipment base and align couplings between driver and driven unit using stainless steel blocks and shims.
 - a. Blocks and shims milled flat and coplanar of both faces.
 - b. Maximum of 3 shims under each foot.
 - c. Size blocks and shims to provide solid support at each mounting bolt location.
 - 1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.
 - d. Provide blocks and shims at each mounting bolt.
 - 1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
 - e. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.
- H. Rotating equipment Couplings:
 1. Align in the annular and parallel positions.
 - a. For equipment rotating at 1200 RPM or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
 - b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
 - c. For equipment rotating at speeds greater than 1200 RPM allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
 2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
 3. Check surfaces for runout before attempting to trim or align units.
- I. Grouting:
 1. After machine base has been shimmed, leveled onto equipment base with jack screws, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
 - a. Extend dam or formwork to cover leveling shims and blocks.
 - b. Grease anchor bolts and jack screws to inhibit grout from adhering to bolts.
 - c. If anchor sleeve were used, fill voids in anchor sleeves with foam to keep grout from filling sleeves.
 - d. Do not use nuts below the machine base to level the unit.
 2. Saturate top of roughened concrete subbase with water before grouting.
 - a. Add grout until entire space under machine base is filled to the top of the base underside.
 - b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
 3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
 - a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.

- b. When the grout has fully hardened (after a minimum of seven days), remove jack screws, tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
- c. Recheck driver-driven unit for proper alignment.

3.2 INSTALLATION CHECKS

- A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
 - 1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.
- B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
 - 1. Has been properly installed and lubricated.
 - 2. Is in accurate alignment.
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts.
 - 4. Has been operated under full load conditions and that it operated satisfactorily.
 - a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.
- C. No separate payment shall be made for installation checks.
 - 1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

- A. Identify equipment and install hazard warning signs in accordance with Section 10 14 00.

3.4 FIELD PAINTING AND PROTECTIVE COATINGS

- A. For required field painting and protective coatings, comply with Section 09 96 00, High Performance Industrial Coatings.

3.5 WIRING CONNECTIONS AND TERMINATION

- A. Clean wires before installing lugs and connectors.
- B. Coat connection with oxidation eliminating compound for aluminum wire.
- C. Terminate motor circuit conductors with copper lugs bolted to motor leads.
- D. Tape stripped ends of conductors and associated connectors with electrical tape.
 - 1. Wrapping thickness shall be 150 percent of the conductor insulation thickness.
- E. Connections to carry full ampacity of conductors without temperature rise.
- F. Terminate spare conductors with electrical tape.

3.6 FIELD QUALITY CONTROL

- A. General:
 - 1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
 - 2. Execute pre-demonstration requirements in accordance with Section 01 75 00.
 - 3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
 - 4. Provide testing of electrical equipment and connections in accordance with the Electrical specifications.
 - 5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
 - a. Contract Drawings and Specifications.
 - b. Related construction change documentation.

- c. Approved Shop Drawings.
 - d. Approved Operation and Maintenance Manuals.
 - e. Other pertinent information as required.
- B. Equipment Monitoring and Testing Plans:
 - 1. Approved in accordance with Shop Drawing submittal schedule.
 - 2. Included as a minimum:
 - a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
 - b. List and description of testing and analysis equipment to be utilized.
 - c. List of all equipment to be testing, including:
 - 1) Name and tag numbers identified in the Contract Documents.
 - 2) Manufacturer's serial numbers.
 - 3) Other pertinent manufacturer identification,
- C. Instruments Used in Equipment and Connections Quality Control Testing:
 - 1. Minimum calibration frequency:
 - a. Field analog instruments: Not more than 6 months.
 - b. Field digital instruments: Not more than 12 months.
 - c. Laboratory instruments: Not more than 12 months.
 - d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
 - 2. Carry current calibration status and labels on all testing instruments.
 - 3. See individual testing programs for additional instrumentation compliance requirements.
- D. Testing and Monitoring Program Documentation:
 - 1. Provide reports with tabbed sections for each piece of equipment tested.
 - 2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
 - a. Include legible copies of all forms used to record field test information.
 - 3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
 - a. Include data gathering and sample test report forms that will be utilized.
 - 4. In the final report, include as a minimum, the following information for all equipment tested:
 - a. Equipment identification, including:
 - 1) Name and tag numbers identified in the Contract Documents.
 - 2) Manufacturer's serial numbers.
 - 3) Other pertinent manufacturer identification,
 - b. Date and time of each test.
 - c. Ambient conditions including temperature, humidity, and precipitation.
 - d. Visual inspection report.
 - e. Description of test and referenced standards, if any, followed while conducting tests.
 - f. Results of initial and all retesting.
 - g. Acceptance criteria.
 - h. "As found" and "as left" conditions.
 - i. Corrective action, if required, taken to meet acceptance.
 - j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
 - k. Instrument calibration dates of all instruments used in testing.
 - 5. Provide three (3) bound final reports prior to Project final completion.
- E. Electrical Equipment and Connections Testing Program:
 - 1. Perform testing on Electrical equipment and connections in accordance with the Electrical specification requirements.
 - 2. Testing of motors:
 - a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15.

- b. Ensure motor has been lubricated.
 - c. Bump motor to check for correct rotation.
- 3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.
- F. Other Testing:
 - 1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
 - 2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
 - a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.
- G. Infrared Thermography Testing Program:
 - 1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.
 - a. Perform on all rotating and reciprocating equipment having drivers 25 HP or greater.
 - b. Perform on electrical equipment and connections: See Section 26 08 13.
 - 2. Additional requirements for infrared thermography monitoring and testing equipment:
 - a. Temperature range: -10 to 350 DEGC.
 - b. Accuracy: ± 2 percent or 2 DEGC, whichever is greater.
 - c. Repeatability: ± 1 percent or 1 DEGC, whichever is greater.
 - d. Temperature indication resolution: 0.1 DEGC.
 - e. Minimum focus distance: 0.3 meters.
 - f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows.
 - 3. Perform inspection per ASTM E1934.
 - a. Operate VFD driven equipment at 100 percent speed during thermographic inspection.
 - 4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DEGC per ASTM E1934.
 - 5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DEGC above the equipment and/or bearing manufacturers published criteria.
 - 6. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.
- H. Equipment Field Vibration Monitoring and Testing Program:
 - 1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
 - 2. Perform field vibration testing on each item of rotating and reciprocating equipment having driver 10 HP and greater
 - 3. Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G6.3 criteria.
 - 4. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
 - a. ANSI/HI 11.6-2012 for Submersible Pumps in a Wet-pit or Dry-pit configuration.
 - b. ANSI/HI 9.6.4-2016 for all other centrifugal pumps.
 - 5. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.
 - 6. Utilize an Engineer approved 3rd party testing agency to perform vibration monitoring and testing on equipment.
 - 7. For variable speed equipment provide vibration testing at no more than 3 percent increments of maximum speed throughout entire operating range.
 - 8. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency.
 - 9. Tolerances for pumping equipment shall be per HI published standards.

10. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
11. Document testing with written report.
 - a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
 - b. Natural frequency of installed equipment utilizing an impact hammer.
 - c. Report to include graphical plots of vibration signature for each test point at a scale which illustrates all vibration levels greater than 0.025 ips RMS.

3.7 DEMONSTRATION

- A. Demonstrate equipment in accordance with Section 01 75 00.

3.8 ABBREVIATION TABLE

- A. As indicated on the Drawings.

END OF SECTION

EXHIBIT A

MANUFACTURER FIELD SERVICE REPORT

This field service report is generic in nature. An electronic copy of this form will be furnished upon request from the Engineer. This report is to reflect that all requirements of the Operations and Maintenance Manual and the individual equipment specification requirements have been performed for the installation and operation and also to provide a baseline for amperage draw for each phase, vibration readings, rotation, alignment and all other applicable tests required to insure that the equipment has been installed properly. A MFSR will be required for each individual piece of equipment requiring a MFSR.

Definitions of Reports:

Initial service report: Required for construction preparations. Equipment delivered to site is in good condition and conforms to specification requirements. Anchor bolts, hardware and ancillary items (piping, flanges, conduits, fuel/power supply) are compatible with equipment.

Interim service report: Required for equipment installation onto base or foundation. Piping connections, electrical and control connections or structural attachment are complete. For equipment stored on site over four weeks, interim service report will document that manufacturer's long-term storage procedures have been incorporated and equipment has not been damaged, nor coatings deteriorated.

Final service report is to be completed when equipment can be started, electrical amperage and voltage draw measured, cold and hot alignments performed, vibration testing and monitoring performed and the equipment is found to be in compliance with Manufacturer's operating parameters and the requirements of the individual equipment specifications.

PROJECT: _____

Report Status:

Initial Service Report completed and submitted on _____

Interim Service Report completed and submitted on _____

Final Service Report completed and submitted on _____

Commencement of Warranty _____

I Description

A. Equipment Name and Identification: _____

B. Serial Number: _____

C. Specification Section Number: _____

D. Manufacturer: _____

E. Representative: _____

F. Type of Service: Initial _____ Interim _____ Final _____

II General Review

A. The above referenced equipment/material/supplies have been inspected, checked, and adjusted. Yes _____ No _____

Summary: _____

B. The above referenced equipment/material/supplies were placed upon properly prepared or suitable substrate. N/A _____ Yes _____ No _____

Summary: _____

C. The above referenced equipment/material/supplies are free from any undue stress imposed by any connected piping, anchor bolts or any other load. N/A _____ Yes _____ No _____

Summary: _____

- D. The above referenced equipment/material/supplies have operated under design conditions.
N/A _____ Yes _____ No _____

Summary: _____

- E. The above referenced equipment/material/supplies have been installed in accordance with the manufacturer's recommendations and the Procurement Documents, require no corrective work, and are hereby approved. Yes _____ No _____

Summary: _____

- F. The above referenced equipment/material/supplies are acceptable to the manufacturer as installed providing the following corrective action(s) are performed:

1. _____
2. _____
3. _____
4. _____
5. _____

III Inspection Checklist

Item	Acceptable (Yes/No)	Readings/Comments
Bearings (1)		
Belts (tension reading)		
Lubrication Levels		
Vibration (1) (2) (MILS/SEC)		
Infrared Thermography (1) (2)		
Starting AMPS		
Full Load AMPS		
Volts		
Rotation		
Jacket Temperature (DEGF)		
Seal Water Flow Rate (GPH or GPM)		
Seal Water Pressure (PSI)		
O-rings/Packing		
Alignment (1)		
Anchor Bolts		
Grout		

Item	Acceptable (Yes/No)	Readings/Comments
Substrate Approval		
Sound level (4 FT from unit) (1) (dB)		
Other		

(1) Inspection or testing reports must be attached.

(2) Provide vibration testing and monitoring procedures for Engineer's review and approval prior to testing.

IV O&M Manuals

- A. The O&M manual as presented contains all information required for proper operation, maintenance, and instruction of this system. N/A ____ Yes ____ No ____

Summary: _____

V Preventive Maintenance

- A. The preventive maintenance summary outlined in the O&M manual is acceptable for operation of the system throughout the warranty period. N/A ____ Yes ____ No ____

Summary: _____

VI Operator Training/Classroom Instruction

- A. Training and instruction have been performed in accordance with the requirements of the Procurement Documents. N/A ____ Yes ____ No ____

- B. Final Training/Classroom Instruction Completed on: _____

Summary: _____

VII Remarks

VIII Certification

I hereby certify, that I, _____, am a duly authorized representative of the manufacturer, that I am empowered by the manufacturer to inspect, approve, and operate his equipment, and that I am authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as modified herein. I also certify that all information contained herein is true and accurate.

By: _____
(Authorized Representative)

For: _____

Date: _____

IX Acknowledgments

By: _____

For: _____
(Contractor)

Date: _____

By: _____

For: _____
(Engineer)

Date: _____

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SECTION 01 65 50
PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Scheduling of product delivery.
 - 2. Packaging of products for delivery.
 - 3. Protection of products against damage from:
 - a. Handling.
 - b. Exposure to elements or harsh environments.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
- C. Payment:
 - 1. No payment will be made to Contractor for equipment or materials not properly stored and insured or without approved Shop Drawings.
 - a. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.2 DELIVERY

- A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.
- B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.
- C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.
- D. Protection and Handling: Provide manufacturer's instructions for storage and handling.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PROTECTION, STORAGE AND HANDLING

- A. Manufacturer's Instruction:
 - 1. Protect all products or equipment in accordance with manufacturer's written directions.
 - a. Store products or equipment in location to avoid physical damage to items while in storage.
 - b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
 - 2. Protect equipment from exposure to elements and keep thoroughly dry.
 - 3. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.

3.2 STORAGE FACILITIES

- A. Temporary Storage Building:
 - 1. Provide a weatherproof temporary storage building specifically for the purpose of providing for protection of products and equipment.
 - 2. Equip building with lockable doors and lighting, and provide electrical service for equipment space heaters and heating or ventilation as necessary to provide storage environments acceptable to specified manufacturers.
 - 3. Provide methods of storage of products and equipment off the ground.
 - 4. Provide this structure within 60 days after Notice to Proceed.
 - a. Locate building on-site where shown on the Drawings or in location approved by Engineer.
 - b. Remove building from site prior to startup and demonstration period.

3.3 FIELD QUALITY CONTROL

- A. Inspect Deliveries:
 - 1. Inspect all products or equipment delivered to the site prior to unloading.
 - a. Reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.
- B. Monitor Storage Area: Monitor storage area to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

END OF SECTION

SECTION 01 73 20
OPENINGS AND PENETRATIONS IN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Methods of installing and sealing openings and penetrations in construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 05 50 00 - Miscellaneous Metals.
 - 4. Section 07 62 00 - Flashing and Sheet Metal.
 - 5. Section 07 84 00 - Firestopping.
 - 6. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - d. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
 - g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - i. A995, Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC):
 - 1) Article 501, Class 1 Locations.
 - b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
 - c. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.3 DEFINITIONS

- A. Hazardous Areas: Areas shown in the Contract Documents as having Class I or Class II area classifications.
- B. Washdown Areas: Areas having floor drains or hose bibbs.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. For each structure provide dimensioned or scaled (minimum 1/8 IN = 1 FT) plan view drawings containing the following information:
 - a. Vertical and horizontal location of all required openings and penetrations.
 - b. Size of all openings and penetrations.
 - c. Opening type.
 - d. Seal type.
3. Manufacturer's installation instructions for standard manufactured products.

1.5 PROJECT CONDITIONS

- A. For purposes of this Project, water table level is elevation 73 ft for the Lower Site and elevation 81 ft for the Upper Site.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe Sleeves:
 1. Areas listed as Corrosive Areas in PART 1:
 - a. Stainless steel, Type 304L.
 - b. Penetrations 24 IN DIA or less: ASTM A269, ASTM A312 or ASTM A554, Schedule 40.
 - c. Penetrations larger than 24 IN DIA: Stainless steel, ASTM A666, Minimum 1/4 IN thickness.
 2. All other Areas:
 - a. Steel, Hot-dipped galvanized after fabrication.
 - b. Penetrations 24 IN DIA or less: ASTM A53, Schedule 40.
 - c. Penetrations larger than 24 IN DIA: ASTM A36, Minimum 1/4 IN thickness.
- B. Backing Rod and Sealant: See Specification Section 07 92 00.
- C. Modular Mechanical Seals:
 1. Acceptable manufacturers:
 - a. Link-Seal.
 2. 304 stainless steel bolts, nuts and washers.
- D. Firestopping Material: See Specification Section 07 84 00.
- E. Sheet Metal Sleeves:
 1. Areas listed as Corrosive Areas in PART 1: Stainless steel: ASTM A240, Type 304L.
 2. All other areas: Galvanized steel: ASTM A653, G90.
 3. Minimum 12 GA.
- F. Commercial Wall Castings:
 1. Ductile iron, ASTM A536.
 2. Grade equal to connecting piping system.

PART 3 - EXECUTION

3.1 FABRICATION

- A. Fabricate pipe sleeves in accordance with Specification Section 05 50 00.
- B. Fabricate sheet metal sleeves in accordance with Specification Section 07 62 00.
- C. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in-place in concrete.
 1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
 2. For commercial castings, cast water stop/anchor with wall pipe.
 3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.

4. For fabricated units, diameter of plate or flange to be 4 IN larger than outside diameter of sleeve, pipe or ductwork.
5. For commercial castings, waterstop/anchor size to be manufacturer standard.
6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

3.2 INSTALLATION AND APPLICATION

- A. Firestopping materials used in fire-resistance rated construction shall be in full compliance with Specification Section 07 84 00.
- B. Seal openings and penetrations in non-fire-resistance-rated construction in accordance with Specification Section 07 92 00.
- C. Obtain prior approval from Engineer when any opening larger than 100 SQIN must be made in existing or newly completed construction.
- D. Perform HVAC penetrations in accordance with NFPA 90A.
- E. Perform electrical penetrations in accordance with NFPA 70, Article 501.
- F. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.
 1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.
- G. Where pipes, conduits or ducts pass through floors in washdown areas, install sleeves with top 3 IN above finish floors.
 1. In non-washdown areas, install sleeves with ends flush with finished surfaces.
- H. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.
- I. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.
- J. Where pipes, conduits or ducts pass through grating, provide banding at the entire perimeter of the opening.
 1. Metal grating: See Specification Section 05 50 00.
- K. Where pipes, conduits or ducts are removed where passing through grating:
 1. Metal grating:
 - a. Provide banding at perimeter and cover opening with 1/4 IN plate of the same material of the grating.
 - b. See Specification Section 05 50 00.
 2. FRP grating:
 - a. Provide full depth cover meeting same loading requirement as existing material or replace grating section.
- L. Do not cut into or core drill any beams, joists, or columns.
- M. Do not install sleeves in beams, joists, or columns.
- N. Do not install recesses in beams, joists, columns, or slabs.
- O. Field Cutting and Coring:
 1. Saw or core drill with non-impact type equipment.
 2. Mark opening and drill small 3/4 IN or less holes through structure following opening outline.
 3. Sawcut opening outline on both surfaces.
 - a. Knock out within sawcuts using impact type equipment.
 - b. Do not chip or spall face of surface to remain intact.
 - c. Do not allow any overcut with saw kerf.

- P. Precast-Prestressed Concrete Construction:
 - 1. Do not cut openings or core drill vertically or horizontally through stems of members.
 - 2. Do not locate or install sleeves or recess sleeves vertically or horizontally through or in stems of members.
 - 3. Cast openings and sleeves into flanges of units.
 - 4. Cast openings larger than 6 IN in diameter or 6 IN maximum dimension in units at time of manufacture.
 - 5. Cast openings smaller than 6 IN in diameter or 6 IN maximum dimensions in flanges of units at time of manufacture or field cut.
- Q. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.
- R. Where area is blocked out to receive sheet metal sleeve at later date:
 - 1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
 - a. Size blockout based on sleeve size required plus 4 to 6 IN each side of sleeve for concrete encasement.
 - b. Provide #4 dowels at 12 IN spacing along each side of blockout with minimum of two dowels required per side.
 - 2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
 - a. Size blockout based on sleeve size required plus 2 to 4 IN each side of sleeve for concrete encasement.
- S. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.
- T. Refer to Drawings for location of fire-rated walls, floors, and ceilings.
 - 1. Utilize firestopping materials and procedures specified in Specification Section 07 84 00 IN conjunction with scheduled opening type to produce the required fire rating.
- U. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.
- V. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.
- W. Modular Mechanical Seals:
 - 1. Utilize one seal for concrete thickness less than 8 IN and two seals for concrete, 8 IN thick or greater.
 - 2. Utilize two seals for piping 16 IN diameter and larger if concrete thickness permits.
 - 3. Install seals such that bolt heads are located on the most accessible side of the penetration.
- X. Backer Rod and Sealant:
 - 1. Install in accordance with Specification Section 07 92 00.
 - 2. Provide backer rod and sealant for modular mechanical seal applications.
 - a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

3.3 SCHEDULES

- A. General Schedule of Penetrations through Floors, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:
 - 1. Provide the following opening and penetration types:
 - a. Type A - Block out 2 IN larger than outside dimensions of duct, pipe, or conduits.
 - b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
 - c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring for wet and/or washdown areas.
 - d. Type D - Commercial type casting or fabrication.

- e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.
 - f. Type F - Integrally cast pipe, duct or conduit.
 - g. Type G - Saw cut or line-drill and remove area 1 IN larger than outside dimensions of duct, pipe or conduit.
 - h. Type H - Core drill.
 - i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
 - j. Type J - Grating Banding for any field cut openings.
2. Provide seals of material and method described as follows.
 - a. Category 1 - Modular Mechanical Seal.
 - b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings. Refer to Specification Section 07 62 00 and roofing Specification Sections for additional requirements.
 - c. Category 3 - 12 GA sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
 - d. Category 4 - Backer rod and sealant.
 - e. Category 5 - Full depth compressible sealant with escutcheons on both sides of opening.
 - f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 IN larger than opening.
 - g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.
 - h. Category 8 - Banding for all grating openings and banding and cover plate of similar materials for abandoned openings.
 3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.
 4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

**SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE
FOR NEW CONSTRUCTION**

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	C F I	7 Not Req 7	D F I ⁽¹⁾	Not Req Not Req 7	C F	7 Not Req
Through floors on grade above water table	C F I	4 Not Req 4	C F I ⁽¹⁾	7 Not Req 7	C F I ⁽¹⁾	4 Not Req 7
Through slab on grade below water table	F	Not Req	F	Not Req	F	Not Req
Through floors in washdown areas	C I	4 4	C H ⁽²⁾ I ⁽¹⁾	4 3 4	F H ⁽²⁾ I ⁽¹⁾	Not Req 3 7
Through walls where one side is a hazardous area	C F I	7 Not Req 7	D F I ⁽¹⁾	Not Req Not Req 7	C F	7 Not Req
Through exterior wall below grade above water table	C F I	7 Not Req 7	C D F I ⁽¹⁾	1 Not Req Not Req 1	F I ⁽¹⁾	Not Req 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	C F I	7 Not Req 7	C D F H ⁽²⁾	1 Not Req Not Req 1	C F H ⁽²⁾ I ⁽¹⁾	7 Not Req 7 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	F	Not Req	F	Not Req	F	Not Req
Through exterior wall above grade	A B C	6 6 6	A B D H ⁽²⁾	5 5 Not Req 5	C H ⁽²⁾	5 4
Roof penetrations	A	2	A	2	A	2
Through interior walls and slabs not covered by the above applications	A C	4 4	A C	4 4	A C F	4 4 Not Req
Grating openings and penetrations	J	8	J	8	J	8

**SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE
FOR EXISTING CONSTRUCTION**

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	B E	7 Not Req	B ⁽¹⁾ E ⁽³⁾ H ⁽²⁾	7 Not Req 7	B ⁽¹⁾ E ⁽³⁾ H ⁽²⁾	7 Not Req 7
Through floors on grade above water table	B	7	B	7	B	7
Through slab on grade below water table	E	Not Req	E	Not Req	E	Not Req
Through floors in washdown areas	G	3	G H ⁽²⁾	3 3	G H ⁽²⁾	3 3
Through walls where one side is a hazardous area	B E	7 Not Req	B ⁽¹⁾ B ⁽³⁾ E H ⁽²⁾	7 1 Not Req 7	B ⁽¹⁾ ⁽³⁾ E H ⁽²⁾	7 Not Req 7
Through exterior wall below grade above water table	B	7	B ⁽¹⁾ B ⁽³⁾ H ⁽²⁾	7 1 7	B ⁽¹⁾ ⁽³⁾ H ⁽²⁾	7 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	B E	7 Not Req	B E H ⁽²⁾	1 Not Req 1	B ⁽¹⁾ ⁽³⁾ E H ⁽²⁾	7 Not Req 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	E	Not Req	E	Not Req	E	Not Req
Through exterior wall above grade	G	6	G ⁽¹⁾ ⁽³⁾ H ⁽²⁾	5 5	G ⁽¹⁾ ⁽³⁾ H ⁽²⁾	5 7
Roof penetrations	G	2	G ⁽¹⁾ ⁽³⁾ H ⁽²⁾	2	G	2
Through interior walls and slabs not covered by the above applications	G	4	G ⁽¹⁾ ⁽³⁾ H ⁽²⁾	4 4	G ⁽¹⁾ ⁽³⁾ H ⁽²⁾	4 4
Grating openings and penetrations	J	8	J	8	J	8

(1) Multiple piping 3 IN and smaller or multiple conduits.

(2) Single pipe 3 IN and smaller or single conduit.

(3) Single pipe or conduit larger than 3 IN.

END OF SECTION

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SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. General requirements for cutting and patching Work.
- B. Scope:
 - 1. Contractor shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.
 - 2. Provide cutting, coring, fitting, and patching, including attendant excavation and fill, required to complete the Work, and to:
 - a. remove and replace defective Work;
 - b. remove samples of installed Work as specified or required for testing;
 - c. remove construction required to perform required alterations or additions to existing construction;
 - d. uncover the Work for Engineer's observation of covered Work, testing, or inspection by testing entities, or observation by authorities having jurisdiction;
 - e. connect to completed Work not performed in proper sequence;
 - f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;
 - g. make connections or alterations to existing or new facilities.
- C. Related Requirements:
 - 1. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 2. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Cutting and Patching Request:
 - a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:
 - 1) Design function or intent of Project.
 - 2) Work of Owner or other contractors retained by Owner.
 - 3) Structural capacity or integrity of an element of the Project, building, or structure.
 - 4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 5) Efficiency, operational life, maintenance, or safety of operational elements.
 - 6) Visual qualities of elements that will be exposed to view after completion of the Work.
 - b. Request shall include:
 - 1) Identification of Project and Contract designation.
 - 2) Description of affected Work of Contractor and work of others (if any) retained by Owner.
 - 3) Necessity for cutting.
 - 4) Effect on work or operations of Owner and other contractors (if any) retained by Owner, and on structural and weatherproof integrity of Project, building, or structure.
 - 5) Description of proposed Work, indicating: scope of cutting and patching; trades that will execute the cutting and patching Work; materials and equipment to be used; extent of refinishing; schedule of operations; alternatives (if any) to cutting and patching, and net effect on aesthetics following completion of finishing Work.

- 6) Indication of entity responsible for cost of cutting and patching, when applicable.
 - 7) Written permission of other prime contractors (if any) whose work will or may be affected.
2. Recommendation Regarding Cutting and Patching:
 - a. Should conditions of work or schedule indicate a change of materials or specified methods, furnish Submit written recommendation to Engineer including:
 - 1) Conditions indicating change.
 - 2) Recommendations for alternative materials or alternatives to specified methods.
 - 3) Material manufacturer's printed recommendations for the proposed product and recommendations of manufacturer's technical representative for the specific application(s). The latter shall be on technical representative's letterhead and shall explicitly indicate the Project and specific cutting and patching application(s) to which the recommendation(s) apply.
 - 4) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.
 3. Product Data:
 - a. Submit manufacturer's published data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
 - b. When not required under other Specifications sections, submit manufacturer's published data on materials to be used for finishing around the cut or patched area(s), together with indication of the location(s) where each is proposed for use.
 - c. Furnish Submittals for patching materials under the associated Specifications section. Submittal to include letter of recommendation from product manufacturer's technical representative indicating on technical representative's letterhead, explicitly indicating:
 - 1) Project name and facility name;
 - 2) specific cutting and patching application(s) to which the recommendations apply;
 - 3) that product manufacturer's technical representative has personally observed and is familiar with conditions in the work area(s) of the subject cutting and patching;
 - 4) materials that are the subject of the Submittal are appropriate for the condition(s) of the proposed patch and will remain durable in the patch's final exposure upon Substantial Completion; and.
 - 5) patching material manufacturer's technical representative's recommendations for surface preparation, installation of patching material(s), and curing.
- B. Informational Submittals: Submit the following:
 1. Written Notification of Cutting and Patching:
 - a. Furnish as a Submittal written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.
 2. X-ray Investigations:
 - a. Proposed method of investigation. Submit and obtain Engineer's acceptance prior to performing x-ray inspections.
 - b. Report of x-ray evaluation of slabs, floors, and walls to be cut or core-drilled.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials – General:
 1. Provide materials that comply with the Contract Documents.
 2. If not shown or indicated in the Contract Documents, use materials identical to existing materials affected by cutting and patching Work.
 3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, provide materials whose installed performance will equal or surpass that of existing materials.

4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.
- B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
1. After core-drilling or sawcutting (as applicable) and before installing the utility or equipment through the penetration, coat exposed concrete and exposed steel with solvent-free, two-component, protective, epoxy resin coating.
 2. Color shall approximate the finish color of the existing surface to be coated.
 3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
 - a. Sikagard 62, by Sika Corporation.
 - b. Or equal.
- C. Grout Materials:
1. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.
- D. Epoxy Bonding Adhesive:
1. Provide two-component, moisture-insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.
 2. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.
 3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
 - a. Euco No.452 MV by Euclid Chemical Co.
 - b. Sikadur 32, Hi-Mod by Sika Corporation.
 - c. Or equal.
- E. Epoxy Patch Material:
1. Product and Manufacturer: .
 2. Engage the manufacturer's representative to observe and recommend a suitable patching material of the actual construction conditions.
 3. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
 - a. Depth of patch greater than 3/4 IN:
 - 1) Five Star MP Epoxy Patch.
 - 2) Or equal.
 - b. Depth of patch between 1/8 IN and 3/4 IN:
 - 1) Five Star Fluid Epoxy.
 - 2) Or equal

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination and Assessment – General:
1. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.
 2. Report unsatisfactory or questionable conditions to Engineer in writing.
 3. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.
- B. Non-Destructive Investigation:
1. In advance of cutting or coring through existing slabs or walls, use x-ray or other non-destructive methods accepted by Engineer to determine location of reinforcing steel, electrical conduits, and other items embedded in slabs and walls.
 2. Submit to Engineer written report of findings of evaluation.
 3. Perform x-ray investigation and submit results to Engineer sufficiently in advance of cutting Work to allow time to identify and implement alternatives, if changes to the Work are necessary because of conduit or other features in floor or wall.

3.2 PREPARATION

- A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.
- B. Protection of Existing Construction during Cutting and Patching:
 - 1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.
 - 2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
 - 3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 CUTTING AND PATCHING – GENERAL

- A. Perform cutting and coring in such manner that limits extent of patching required.
- B. Structural Elements:
 - 1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.
- C. Operating Elements:
 - 1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.
 - 2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.
- D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.
- E. Provide adequate temporary covering over openings (whether cut or core-drilled) where not in use. Avoid creating tripping hazards for openings provided in floors and slabs.

3.4 CORING

- A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by Engineer in writing.
- B. Coring:
 - 1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.
 - 2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of Engineer. To extent possible, avoid cutting reinforcing steel in slabs and walls.
- C. Protection:
 - 1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.
 - 2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specification Section. Apply protective coating in accordance with manufacturer's instructions.
- D. Cleaning:
 - 1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

3.5 CUTTING

A. Cutting – General:

1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.
2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping. Carefully chip out concrete where necessary and as indicated in the Contract Documents.
3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.
4. Prior to starting cutting, provide adequate bracing of area to be cut.
5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
6. Use equipment of adequate size to remove the cut panel or “coupon”.

B. Cutting – Concrete and Masonry:

1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
2. On both sides of the element being cut, provide for control of slurry generated during sawing.
3. Concrete Cutting:
 - a. Make openings by sawing through existing concrete. Core drill with 6 IN DIA core at the corners of openings to avoid overcutting at corners.
 - b. When the cut-out concrete or “coupon” cannot be removed in one piece, or where concrete is too thick for saw to penetrate fully, break out concrete after initial saw cuts.
 - c. Where saw cutting is not possible:
 - 1) Make openings by drilling holes around perimeter of required opening and subsequently carefully chip out concrete.
 - 2) Holes shall be sufficient in quantity to prevent damage to remaining concrete.
4. Sizing and Repair of Cut Concrete Surfaces:
 - a. Where reinforcing steel is cut, for openings indicated on the Drawings, remove existing reinforcing steel back to 1.5 IN below concrete surface. When using heat or torching to remove ends of reinforcing steel, remove adjacent, heat-damaged concrete prior to patching. Sides of resulting hole to be patched shall be approximately perpendicular to finished concrete surface. Provide bonding adhesive on surfaces of resulting holes and fill resulting holes with non-shrink grout in accordance with the Contract Documents.
 - b. Oversize required openings in existing concrete by one inch on all sides and build back to required opening size by providing epoxy grout bonded to existing concrete.
 - c. Where oversizing the cut opening by one inch is not possible, cut the opening to the required dimensions. After cutting concrete and before installing subsequent construction on or through the opening, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specifications Section. Apply protective coating in accordance with manufacturer’s instructions.
 - d. Where indicated, finish remaining surfaces as indicated in Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

3.6 PATCHING

A. Patching – General:

1. Patch large openings to be filled with concrete in accordance with the Contract Documents. Before installing new concrete, apply bonding adhesive indicated in Paragraph 2.1.C of this Specifications section in accordance with manufacture’s recommendations.
2. Where large openings to be filled with concrete are indicated on the Drawings as requiring reinforcing steel, provide reinforcing steel as shown and indicated in the Contract Documents. Where openings in existing reinforced concrete are larger than 2 FT in diameter or 2 FT by 2 FT and the Drawings or elsewhere in the Contract Documents do not

expressly require reinforcing steel for the opening, submit a request for interpretation to Engineer and obtain Engineer's response before proceeding.

3. Where concrete infill or grout repair materials are not used, patch using epoxy patch material indicated in Paragraph 2.1.D of this section unless otherwise indicated on Drawings.
 4. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.
 5. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents and the published installation instructions of the material's manufacturer.
 6. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
 7. Where feasible, test patched areas to demonstrate integrity of installation.
- B. Restoration:
1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.
 2. For continuous surfaces, refinish to nearest intersection.
 3. For an assembly, refinish the entire unit that was patched.
 4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 CLEANING

- A. Cleaning and Restoration:
1. Perform cleaning promptly after associated cutting, coring, and patching.
 2. Clean areas and spaces where cutting, coring, or patching were performed.
 3. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.
 4. Restore damaged coverings of pipe and other utilities to original condition.

END OF SECTION

SECTION 01 74 23

CLEANING

PART 1 - GENERAL

1.1 FIRE PROTECTION

- A. Store volatile waste in listed disposal containers.
- B. Maintain site and building so no condition provides a fire hazard.
- C. Remove combustible debris from building at end of each shift and from site daily.
- D. Sources of ignition and smoking are prohibited in flammable and combustible storage areas.
- E. Do not burn on-site.

1.2 POLLUTION CONTROL

- A. Conduct cleanup and disposal operations to comply with codes, rules, regulations, ordinances, and anti-pollution laws.
- B. Do not burn or dispose of combustible debris, rubbish and waste material on site.
- C. Do not discharge volatile, harmful, or dangerous materials into storm or sanitary drains or sewer systems.
- D. Prevent accumulation of wastes that create hazardous conditions.
- E. LEED Requirements:

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Use materials recommended by manufacturers of surfaces to be cleaned.
- B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.
- C. Use only those cleaning materials which will not create hazards to health or property and will not damage surfaces.

2.2 CLEANING MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property, are non-toxic to both humans and aquatic life, and will not damage surfaces, and comply with the following:

PART 3 - EXECUTION

3.1 GENERAL

- A. Clean items installed under this Contract.
 - 1. Leave free of stains, dirt, dust, damage, or defects.
 - 2. Include washing, sweeping, polishing of wall surfaces, floors, windows, hardware, mirrors, lighting fixtures, equipment, etc.

3.2 DURING CONSTRUCTION

- A. Provide on-site listed disposal containers for collection of waste materials, debris, and rubbish.
 - 1. Dispose of off-site once a week at an approved solid waste disposal site.
 - 2. Cover container to prevent blowing by wind.

- B. Keep work areas clean so as not to hinder health, safety or convenience of personnel in existing facility operations.
- C. Interior cleaning:
 - 1. Clean and vacuum interior space prior to start of painting, and continue cleaning as-needed until substantial completion.
 - 2. Schedule cleaning operations so contaminants do not fall on wet painted surfaces.
 - 3. Clean and protect Work in progress and adjoining materials in place, during handling and installation.
 - 4. Clean lunch/break area after each use.
- D. Exterior cleaning:
 - 1. Wet down dusty materials and rubbish to prevent blowing dust during entire construction period.
 - 2. If use of water is prohibited by law, seek an alternate method to prevent blowing dust.
 - 3. Perform cleaning operations as required during construction to prevent accumulations of dust, soil, and debris.
 - 4. Keep weeds and other vegetation trimmed to 3 IN maximum height.
 - 5. Remove snow and ice from access to buildings.

3.3 FINAL CLEANING

- A. At Substantial Completion, perform final cleaning of Work and existing areas wherever any area are left less than clean by construction operations.
 - 1. Complete cleaning operations before requesting review for Substantial Completion.
- B. Use experienced professional cleaners for final cleaning.
- C. Repair and touch-up marred areas.
- D. Broom clean and remove stains from paved surfaces; rake clean other surfaces of grounds.
- E. Ventilation systems:
 - 1. Clean permanent filters and replace disposable filters if units were operated during construction.
 - 2. Clean ducts, blowers, and coils in air conditioning units operated during construction.
- F. Remove grease, dust, dirt, stains, labels, fingerprints, mastic, adhesive, and foreign materials from interior and exterior surfaces, and fixtures, hardware, and equipment.
- G. Wash and shine glazing, mirrors, stainless steel, etc., including existing windows in area of construction.
- H. Wipe all lighting fixture reflectors, lenses, lamps and trims clean.
 - 1. Replace all burned out lamps.
- I. Polish glossy surfaces to a clear shine.
- J. Remove temporary protection and facilities installed for protection of the Work during construction.

3.4 FIELD QUALITY CONTROL

- A. Prior to Owner occupancy, Contractor and Owner shall conduct an inspection of interior and exterior surfaces and Work areas to verify Project is clean to Owner's satisfaction.

END OF SECTION

SECTION 01 75 00

CHECKOUT AND START-UP PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative and procedural requirements for checkout and startup of equipment, systems, and facilities.
- B. Scope:
 - 1. Contractor shall initially check out, start up, and place equipment and systems installed under the Contract into successful operation, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
 - 2. Provide the following:
 - a. All labor, tools, materials, and equipment required to complete equipment and system checkout and startup.
 - b. Chemicals, lubricants, and other required operating fluids necessary for checkout, startup, and initial operation of the Work.
 - c. Filters and other temporary or consumable items necessary for checkout, startup, and initial operation of the Work.
 - d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and startup of equipment and systems, unless otherwise specified.
 - 3. The General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 19 - Closeout Requirements, address requirements for documenting Substantial Completion.
- C. Related Sections include but are not necessarily limited to:
 - 1. Section 01 33 04 - Operation and Maintenance Manuals
 - 2. Section 11 00 00 - Equipment - Basic Requirements.
 - 3. Section 01 77 19 - Closeout Requirements.
 - 4. Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
 - 5. Section 40 61 13 - Process Control Systems - General Requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate checkout and startup with other contractors, as necessary.
 - 2. Do not start up equipment or system(s) for continuous operation until all components of that equipment item or system, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
 - 3. Subject to the constraints of this Specifications section, facility manager will furnish sufficient personnel to assist Contractor in starting up equipment and system(s), but responsibility for proper operation of the Work is Contractor's.
 - 4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to Engineer or otherwise required by the Contract Documents.
 - 5. For startup of heating equipment, air conditioning equipment, and other equipment and systems that provide temperature control, that are dependent upon the time of year, return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate equipment and system(s).
 - 6. Do not start up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals by Contractor in accordance with the Contract Documents.

B. Checkout and Startup Planning Meeting:

1. Contractor, with appropriate Subcontractors and Suppliers, shall attend and participate in a meeting with Owner, facility manager, and Engineer to discuss planning, scheduling, and coordination of checkout and startup activities.
2. Upon mutual concurrence of Owner, facility manager, Engineer, and Contractor, meeting may be concurrent with the training scheduling planning meeting required in Section 01 79 23 – Instruction of Operations and Maintenance Personnel.
3. Meeting shall be held by the earlier of: (1) not less than 60 days prior to first scheduled training session for the equipment and system(s) to be checked out and started-up, and (2) not less than 60 days prior to the checkout and startup of the associated equipment and system(s).
4. Attend meeting prepared to knowledgably and effectively discuss:
 - a. Status of the Work and schedule-to-complete for requirements prerequisite to checkout and startup.
 - b. Schedule for and status of training required for each equipment item and system.
 - c. Schedule for checkout, startup, and field quality control activities for the subject Work.
 - d. Status and quantities of required consumables, lubricants, and utility services necessary for checkout and startup.
5. Meeting will be chaired by Engineer. Engineer will prepare and distribute a record of topics discussed and decisions made during the meeting. If meeting is concurrent with the training planning meeting required under Section 01 79 23 - Instruction of Operations and Maintenance Personnel, Contractor shall chair and prepare minutes of the training scheduling planning portion of the meeting and furnish its draft minutes to Engineer to incorporate into the overall minutes.
6. Comply with decisions made at the meeting and the Contract Documents.

C. Scheduling:

1. Progress Schedule:
 - a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, startup, and field quality control activities, including all demonstration testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, startup, and field quality control activities for each equipment item and system.
 - b. Perform startup and field quality control activities on the associated, scheduled dates, unless otherwise acceptable to Owner, facility manager, and Engineer.
2. Restrictions for Scheduling:
 - a. Checkout of materials, equipment, and systems by Contractor that do not involve or require Owner's or facility manager's personnel may be performed at any time during normal working hours. Where required by the Contract Documents or requested by Engineer, perform checkout in the presence of Engineer or Resident Project Representative (RPR).
 - b. Startup, including initial operation of materials, equipment, and systems, shall not be initiated on: Monday, Friday, Saturday, Sunday, Owen's holidays, the day immediately prior to a holiday, or the day immediately following a holiday, unless otherwise acceptable to Owner, facility manager, and Engineer.
 - c. Unless otherwise indicated in the Contract Documents or acceptable to Owner, facility manager, and Engineer, perform all startup during normal working hours of the day shift.
 - d. To the extent practicable, where extended-duration startup or field quality control activities are required by the Contract, avoid having such activities extend into evening, night, weekend, or holiday hours.
 - e. Owner reserves the right to require a minimum seven days' notice of rescheduled startup when Contractor cannot perform the associated activities as scheduled.

3. Operation and Maintenance Data:
 - a. Comply with Section 01 33 04 - Operation and Maintenance Manuals.
 - b. A preliminary copy of all operation and maintenance manuals shall be received by Engineer prior to the start of the demonstration period "OAT".
4. Training:
 - a. Comply with Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
5. Spare Parts, Tools, and Extra Materials.
 - a. Deliver to Owner or facility manager (as applicable) all required spare parts, tools, and extra materials prior to commencing the demonstration period "OAT", unless earlier delivery is required elsewhere in the Contract Documents.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Do not start up equipment or systems or place into initial operation until required operating permits are obtained from authorities having jurisdiction.
 2. Where Owner (with or without assistance of Engineer) has applied for and obtained initial approvals or permits necessary for operation, Contractor shall furnish information and assistance to Owner or Engineer for Owner to secure final approvals from authorities having jurisdiction for required operating permits.
- B. Qualifications:

1.4 DEFINITIONS

- A. The following defined terms are used in this Specifications Section:
 1. Instrumentation Supplier: Entity retained by Contractor, Subcontractor, or Supplier to furnish instrumentation or controls that will be part of the completed Work, including manufacturers, manufacturer representatives, wholesalers, retailers, and others, including entities retained to perform systems integration Work.
 2. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:
 - a. Finishing type construction work to ensure the Project has reached a state of Substantial Completion.
 - b. Equipment start-up.
 - c. Personnel training.
 3. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the facility and starts up and operates the facility, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the facility Project Classified System as evidence of Substantial Completion.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Data collection and reporting log for each required Demonstration Period.
- B. Informational Submittals: Submit the following:
 1. Progress Schedules indicating dates for checkout, startup, and field quality control activities.
 2. Completed checkout and startup log required in Paragraph 3.2.C of this Specifications section.
 3. Manufacturer's installation check letters (also known as Manufacturer's Field Services Report) required in Paragraph 3.2.C of this Specifications section.
 4. Instrumentation Supplier's Instrumentation Installation Certificate, required in Paragraph 3.2.C of this Specifications section.
 5. Letter verifying completion of all pre-demonstration startup activities, required in Paragraph 3.2.C of this Specifications section.

6. Report of data collected during each required Demonstration Period.
7. Qualifications Statements:
 - a. Qualifications, including resume' and copy of license, of Contractor-retained licensed operator.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CHECKOUT AND STARTUP – GENERAL

- A. Facility Startup Divided into Two Periods:
 1. Pre-Demonstration Period including:
 - a. Obtain Engineer's approval or acceptance (as applicable) of Submittals required prior to checkout and startup, including all Shop Drawings, Samples, source quality control (shop testing) Submittals, preliminary operation and maintenance manuals, and other Submittals required by the Contract Documents, other than Submittals that cannot be furnished until after startup.
 - b. Complete the Work to a point ready for checkout and startup, including operation available in all manual, automatic, and other modes.
 - c. Checkout and initial field quality control activities that can be performed prior to startup of the equipment or system.
 - d. Startup of the associated Work.
 - e. Field quality control activities for the subject Work as indicated elsewhere in the Specifications and other Contract Documents, other than this section.
 - f. Training of operations and maintenance personnel.
 2. Demonstration Period, including:
 - a. Demonstration of functional integrity of equipment, system, or PCS.

3.2 PRE-DEMONSTRATION PERIOD

- A. Prior to the Pre-Demonstration Period, complete the Work to the point where it is ready for checkout and startup.
- B. Checkout.
 1. Comply with Section 11 00 00 - Equipment - Basic Requirements, including provisions concerning installation checks
- C. Startup:
 1. Comply with requirements for startup of materials, equipment, and systems indicated in the associated Specification sections and elsewhere in the Contract Documents.
 2. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
 3. Perform startup to extent possible without introducing process flow.
 4. Test tanks, pumping and similar equipment requiring a fluid, using clean water supplied at Contractor's expense.
 5. Introduce process flow to complete startup:
 - a. .
 6. Procedures include but are not necessarily limited to the following:
 - a. Test or check and correct deficiencies of:
 - 1) Power, control, and monitoring circuits for continuity prior to connection to power source.
 - 2) Voltage of all circuits.
 - 3) Phase sequence.
 - 4) Cleanliness of connecting piping systems.
 - 5) Alignment of connected machinery.
 - 6) Vacuum and pressure of all closed systems.

- 7) Lubrication.
- 8) Valve orientation and position status for manual operating mode.
- 9) Tankage for integrity using process flow.
- 10) Pumping equipment using process flow.
- 11) Instrumentation and control signal generation, transmission, reception, and response.
 - a) Comply with Section 40 61 13 - Process Control System General Requirements.
- 12) Tagging and identification systems.
- 13) Proper connections, alignment, calibration and adjustment.
- b. Calibrate safety equipment.
- c. Manually rotate or move moving parts to assure freedom of movement.
- d. "Bump-start" electric motors to verify proper rotation.
- e. Perform other tests, checks, and activities required to make the Work ready for Demonstration Period.
- f. Checkout and Startup Log:
 - 1) Prepare a log showing each equipment item and system requiring checkout and startup. Indicate in the log activities to be accomplished during checkout and startup.
 - 2) Provide a place for Contractor to record date and person performing required checkout and startup. Indicate associated date(s), personnel, and employer of each.
 - 3) Submit completed checkout and startup log to Engineer and obtain Engineer's acceptance.
- 7. Obtain Suppliers' certifications of the installed and operational Work, without restrictions or conditions, and submit to Engineer:
 - a. Manufacturer's installation check letters (sometimes referred to as Manufacturer's Field Services Report).
 - b. Instrumentation Supplier's Instrumentation Installation Certificate.
- 8. Letter verifying completion of all pre-demonstration startup activities including receipt of all specified items from Suppliers as final item prior to initiation of Demonstration Period.
- 9. Personnel Training:

3.3 DEMONSTRATION PERIOD

- A. Demonstration Period – General:
 - 1. Demonstrate the operation and performance of mechanical, electrical, instrumentation, and control interfaces of the Work undergoing the Demonstration Period, in accordance with the Contract Documents.
 - 2. Duration of Demonstration Period: 120 consecutive hours.
 - 3. If, during the Demonstration Period, the aggregate time used for repair, alteration, or unscheduled adjustments to any part of the Work that renders the affected Work inoperative or operation outside of recommended ranges exceeds 10 PCT of the Demonstration Period, the demonstration of operation and performance will be deemed unacceptable and Contractor shall provide appropriate adjustments and remedies and re-perform the Demonstration Test, at no additional cost to Owner or facility manager, until acceptable results are obtained. Re-performance of the Demonstration Period shall comply with the same requirements as the original Demonstration Period.
 - 4. Perform the demonstration of operation and performance of the Work under full operational conditions.
 - 5. Owner's or Facility Manager's Personnel:
 - a. Owner or facility manager (as applicable) will make available operations personnel to make process decisions affecting facility performance and compliance with applicable operating permits.
 - b. Owner's or facility manager's assistance will be available only for process decisions.

- c. Contractor will perform all other functions associated with the Demonstration Period including but not limited to equipment operation and maintenance until successful completion of the Demonstration Period in accordance with the Contract Documents.
- 6. Owner or facility manager reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, and similar actions and events during the Demonstration Period to verify the operation and performance of the Work in automatic, manual, and other types of operating modes, backup systems, and alternate operating modes.
- 7. Prior to Starting Demonstration Period:
 - a. Prepare data collection and reporting log for sampling, analytical data, and data to be obtained by manually recording data from field or panel indicators. Not less than 30 days prior to the start of the Demonstration Period, submit the data collection and reporting log to Engineer for acceptance.
- 8. Timing of Start and End of Demonstration Period:
 - a. Schedule the end of the Demonstration Period at a convenient time such as midnight, so the Owner or facility manager can assume operational responsibility on a new day beginning immediately after completion of the Demonstration Period.
 - b. Time of beginning and ending Demonstration Period shall be agreed upon by Contractor, Owner (and facility manager, if other than Owner), and Engineer in advance of initiating Demonstration Period.
- B. Demonstration Period, Evaluation, and Acceptance:
 - 1. Throughout the Demonstration Period, provide knowledgeable personnel to answer Owner's or facility manager's questions, provide final field instruction on select systems (where appropriate) and to respond to problems or failures of the Work.
 - 2. Responsibilities for Sampling and Data Collection:
 - a. Use the data collection and reporting log format accepted by Engineer. Indicate data clearly and legibly.
 - b. .
 - 3. Responsibilities for Data Reporting:
 - a. .
 - b. Submit data collected to Engineer for evaluation of acceptability of results.
 - 4. Data Evaluation:
 - a. Engineer, in consultation with Owner and facility manager (as applicable) as necessary, will evaluate the data collected during the Demonstration Period and other information obtained during the Demonstration Period for compliance with the Contract Documents.
 - b. Engineer will advise Contractor in writing of whether the data and information obtained indicate that the Demonstration Period was successfully completed.

END OF SECTION

SECTION 01 77 19

CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for:
1. Substantial Completion.
 2. Final inspection.
 3. Request for final payment and acceptance of the Work.

1.2 SUBSTANTIAL COMPLETION

- A. Substantial Completion – General:
1. Prior to requesting inspect no for Substantial Completion, perform the following for the substantially completed Work:
 - a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
 - b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
 - c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Engineer's acceptance of, field quality control tests and inspections required by the Contract Documents.
 - d. Complete checkout and startup in accordance with Section 01 75 00 - Checkout and Startup Procedures, requirements of the Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
 - e. Training of the facility's operations and maintenance personnel shall be completed in accordance with the Contract Documents, including Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
 - f. Submit and obtain Engineer's acceptance of final operations and maintenance manuals in accordance with Section 01 33 04 - Operation and Maintenance Manuals.
 - g. Obtain and submit to Engineer all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
 - h. Complete other tasks that the Contract requires be completed prior to Substantial Completion.
 2. Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Supplementary Conditions.
 3. Sample letter for Contractor's request for inspection for Substantial Completion is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project and the needs of Contractor's request.
 4. Unless decided otherwise by Owner and Engineer, form of certificate of Substantial Completion will be EJCDC C-625, "Certificate of Substantial Completion" (2018 edition or later), prepared by Engineer.

1.3 FINAL INSPECTION

- A. Final Inspection – General:
1. Prior to requesting final inspection, verify that all the Work is fully complete and ready for final payment. Partial checklist for this purpose is attached to this Specifications section.

2. Sample letter for Contractor to request final inspection is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project.
3. Procedures for requesting and documenting the final inspection are in the General Conditions, as may be modified by the Supplementary Conditions, and as augmented in this Specifications section.

1.4 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:

1. After successful completion of the final inspection, submit request for final payment in accordance with the Agreement and General Conditions.
2. Acceptance of the Work:
 - a. Upon Engineer's concurrence that the Work is complete and ready for final payment (as a result of the final inspection and other communications between the parties and Engineer) and receipt of the final Application for Payment, accompanied by other required Contract closeout documentation, all in accordance with the Contract Documents, Engineer will issue to Owner and Contractor a notice of acceptability of the Work, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
 - b. Unless decided otherwise by Owner and Engineer, form of acceptance will be EJCDC C-626, "Notice of Acceptability of Work", (2018 edition or later).
 - c. Nothing other than receipt of such notice of acceptability from Engineer constitutes acceptance of the Work.
 - d. Receipt of Engineer's notice of acceptability of the Work does not relieve Contractor of Contractor's continuing obligations under the Contract, including correction period obligations, warranty obligations, indemnification obligations, insurance requirements, and Contractor's other obligations following acceptance of the Work by Engineer and final payment. Such obligations shall commence and remain in effect as indicated elsewhere in the Contract Documents.

B. Request for final payment shall include:

1. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
2. List, on Contractor's letterhead, of all Change Proposals, Claims, and disputes that Contractor believes are unsettled. If there are no such Change Proposals, Claims, or disputes, so indicate in writing.
3. Consent of Surety to Final Payment:
 - a. Acceptable form includes AIA G707, "Consent of Surety to Final Payment" (1994 or later edition), or other form acceptable to Owner.
4. Releases of Liens:
 - a. Submit complete and legally effective releases (satisfactory to Owner) of all Liens filed in connection with the Work, regardless of whether such Lien was filed by Contractor, Subcontractor, or Supplier.
 - b. Each release of Lien shall be signed by an authorized representative of the entity submitting the release of Lien, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.
5. Waivers of Lien Rights:
 - a. Submit legally-binding waivers of rights to file Liens, acceptable to Owner, as required in the General Conditions (as may be modified by the Supplementary Conditions) from Contractor and each Subcontractor and Supplier that furnished or provided labor, material, or equipment totaling \$1,000 or more for the Work.
 - b. Each waiver of Lien rights shall be signed by an authorized representative of the entity submitting waiver of Lien rights, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.
 - c. Waiver of Lien rights may be conditional upon receipt of final payment.

- d. Required Affidavits: Submit the following:
 - 1) Affidavit of payment of debts and claims, submitted by Contractor. Acceptable form includes AIA G706, "Contractor's Affidavit of Payment of Debts and Claims" (1994 or later edition), or other form acceptable to Owner, and;
 - 2) Affidavit of release of Liens, submitted by Contractor. Acceptable form includes AIA G706A, "Affidavit of Release of Liens" (1994 or later edition).
 - 3) Each affidavit shall be signed by an authorized representative of Contractor and shall bear Contractor's corporate seal, as applicable.
- e. In the event Contractor is unable to obtain one or more required waivers of Lien rights, recourse is set forth in the General Conditions, as may be modified by the Supplementary Conditions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

- A. The documents listed below, following this Specification section's "End of Section" designation, are part of this Specifications section:
 - 1. Sample letter for Contractor's use in requesting inspection for Substantial Completion (two pages).
 - 2. Sample partial checklist to identify readiness for final inspection (four pages).
 - 3. Sample letter for Contractor's use in requesting final inspection (one page).
- B. In the model language of the attached sample letters for Contractor to request inspection for Substantial Completion and the final inspection, italicized language in brackets, e.g., "insert date" indicates instructions to the drafter of the letter and often indicates specific information to be inserted by Contractor; do not include bracketed, italicized text in the final version of the letter(s) prepared for the Project. Non-italicized language in brackets is optional language; use the appropriate language to complete the actual letter for the Project and edit where required to suit the specific circumstances.

END OF SECTION

SAMPLE PARTIAL CHECKLIST TO IDENTIFY READINESS FOR FINAL INSPECTION

Project: _____

Contract: _____

Contractor: _____

Item No./Description	Completed/Date	In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
1. All Submittals, including all Shop Drawings and Samples, approved or accepted by Engineer	☐	☐	☐	☐		
<i>Remarks:</i>						
1. Final services completed by Suppliers, including submittal of "Manufacturer Field Service Report" Equipment - Basic Requirements	☐	☐	☐	☐		
<i>Remarks:</i>						
2. Final Work completed by Subcontractors	☐	☐	☐	☐		
<i>Remarks:</i>						
3. Permits closed out and regulatory compliance transitioned from construction to operations	☐	☐	☐	☐		
<i>Remarks:</i>						
4. All outstanding change issues are addressed and all Change Proposals submitted	☐	☐	☐	☐		
<i>Remarks:</i>						
5. All Change Proposals and Claims are resolved	☐	☐	☐	☐		

Item No./Description	Completed/Date	In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
Remarks:						
6. All defective Work of which Contractor is aware has been corrected in accordance with the Contract Documents	☐	☐	☐	☐		
Remarks:						
7. Issues related to Constituents of Concern and potential Hazardous Environmental Condition have been fully addressed	☐	☐	☐	☐		
Remarks:						
8. All spare parts, tools, and extra materials have been furnished in accordance with the Contract Documents, and documentation thereof submitted to Engineer	☐	☐	☐	☐		
Remarks:						
9. All final operations & maintenance manuals have been submitted and accepted by Engineer	☐	☐	☐	☐		
Remarks:						
10. Manufacturer warranties and software license(s) furnished	☐	☐	☐	☐		
Remarks:						
11. Instruction and training of operations and maintenance personnel is complete and records of training submitted	☐	☐	☐	☐		

Item No./Description	Completed/Date	In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
Remarks:						
12. MBE/WBE/DBE/VBE compliance report(s) submitted (when applicable)	☐	☐	☐	☐		
Remarks:						
13. All field engineering Submittals, including survey data, furnished	☐	☐	☐	☐		
Remarks:						
14. All Work on "punch list" is complete in accordance with the Contract Documents	☐	☐	☐	☐		
Remarks:						
15. All record documents submitted to and accepted by Engineer	☐	☐	☐	☐		
Remarks:						
16. Contractor is fully demobilized from the Site	☐	☐	☐	☐		
Remarks:						
17. All Site restoration is complete	☐	☐	☐	☐		
Remarks:						
18. Final cleaning of all work areas is complete	☐	☐	☐	☐		
Remarks:						
19. Releases of Liens and waivers of Lien rights (or acceptable	☐	☐	☐	☐		

Item No./Description	Completed/Date	In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
alternative) obtained from Subcontractors and Suppliers						
Remarks:						
20. Evidence of Contractor liability insurance furnished for correction period	☐	☐	☐	☐		
Remarks:						
21. All other required Contract closeout documents obtained	☐	☐	☐	☐		
Remarks:						
Remarks:						
22. All other Work and documentation required prior to final payment is complete and provided in accordance with the Contract Documents	☐	☐	☐	☐		
Remarks:						

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide instruction for equipment and systems which require Operation and Maintenance Data specified in technical sections.

1.2 QUALITY ASSURANCE

- A. Instructors:
 - 1. Member of installer's staff, and authorized representative of component, assembly, or system manufacturer.
 - 2. See specification technical sections for additional requirements.

1.3 SUBMITTALS

- A. Contract Closeout Information:
 - 1. Transmittal letter indicating Owner's receipt of required demonstrations, copies of completed reports and video files.

1.4 JOB CONDITIONS

- A. Complete instruction prior to Substantial Completion.
 - 1. Submit separate report for each system or type of equipment to Owner for approval.
 - a. Submit report form attached, with preliminary information to Owner at least two (2) weeks prior to first instruction period.
 - b. Submit completed report to Owner and Architect.
 - 2. Submit video files for each instruction to Owner.
 - a. Name each file with description of equipment or system.
 - b. Provide index of instruction files.
 - c. Provide on DVD.

PART 2 - EXECUTION

2.1 PREPARATION

- A. Assemble instructional aids.
- B. Supply operation and maintenance data for use during instruction.
- C. Provide video equipment available for each instruction.
- D. Schedule instruction with Owner when component, assembly, or system has been tested, is in correct operating condition and is fully functional.

2.2 INSTRUCTION

- A. Provide video and physical instruction.
- B. Explain use of operating and maintenance manuals.
- C. Furnish tools required.
- D. Instruct Owner's personnel in operation and maintenance of equipment and systems.
 - 1. Provide instruction to satisfaction of Owner.
- E. Tour building areas involved and identify:
 - 1. Maintenance points and access.
 - 2. Control locations and equipment.

- F. Operating Sequences:
 - 1. Identify location and show operation of switches, valves used to start, stop and adjust systems.
 - 2. Explain use of flow diagrams and operating sequence diagrams.
 - 3. Demonstrate operation through complete cycle or cycles and full range of operational modes, including testing and operational adjustment.
- G. Control Equipment:
 - 1. Temperature settings.
 - 2. Switch modes.
 - 3. Available adjustments.
 - 4. Reading of gauges.
 - 5. Functions serviced only by authorized factory representatives.
- H. Troubleshooting:
 - 1. Demonstrate common occurring problems.
 - 2. Identify procedures requiring attention of factory personnel.
- I. Maintenance Procedures:
 - 1. Identify items requiring periodic maintenance.
 - 2. Demonstrate preventive maintenance procedures and recommended maintenance intervals.
 - 3. Demonstrate commonly occurring maintenance procedures not part of preventive maintenance program.
 - 4. Identify maintenance tools and materials used.

END OF SECTION

EQUIPMENT AND SYSTEMS OWNER INSTRUCTION REPORT

Project: _____

Project Number: _____

Contractor: _____

System or Equipment: _____

Specification Section: _____

PRELIMINARY INFORMATION

To be completed by Contractor/Construction Manager:

Proposed dates for instruction period: _____ to
_____.

Contractor Representative conducting instruction:
_____.

Number of hours of instruction required by Contract Documents: _____.

To be completed by Owner:

Owner's personnel to be instructed (designate supervisor if required).

Contractor's Representative/Construction Managers Representative to maintain and complete this report during course of instruction.

Instruction Log						
Date	Hours	Material Covered	Instructor Initials	Owner's Personnel Receiving Instruction	Personnel Initials	Comments

Total Hours Completed: _____

Instructor's Signature: _____

Date Instruction Completed: _____

Owner's Signature: _____

Distribution: ☐ Owner ☐ Architect ☐ Construction Manager ☐ Contractor

end instruction report

SECTION 01 79 23

INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative and procedural requirements for instruction of operations and maintenance personnel.
 - 2. Qualifications requirements for Suppliers' training personnel.
 - 3. General requirements for training.
 - 4. Schedule of required training sessions.
- B. Scope:
 - 1. Contractor shall furnish services of Suppliers' operation and maintenance training specialists to instruct Owner's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
 - 2. Each Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
Owner reserves the right to record training sessions on video for Owner's or facility manager's later use in instructing Owner's or facility manager's personnel.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Scheduling of Training Sessions:
 - 1. General:
 - a. Contractor shall coordinate training services with checkout, startup, and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner and facility manager, in accordance with the Contract Documents.
 - b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Provide training services at the required days and times at no additional cost to Owner.
 - 2. Prerequisites to Training:
 - a. Training of facility operations and maintenance personnel shall commence after preliminary operation and maintenance data has been submitted and accepted by Engineer, and the Work required in Section 01 75 00, Checkout and Startup Procedures, is complete.
 - b. At option of Owner or Engineer, training may be allowed to take place before, during, or after checkout and startup of materials and equipment.
 - 3. Training Schedule Submittal:
 - a. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer and Owner. Proposed training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.
 - b. Training Schedule Coordination: When Project has multiple prime contracts, prime Contractors shall comply with this Specifications section. All prime Contractors shall coordinate with the General Contractor in developing a single training schedule Submittal for the entire Project, to be submitted by General Contractor. All prime Contractors shall implement training in accordance with the approved training schedule.
 - c. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training schedule,

incorporating revisions in accordance with Engineer's comments, not later than 30 days prior to starting the first training session.

- d. Owner or facility manager reserves the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

B. Training Scheduling Conference:

1. Prior to preparing initial training schedule Submittal, schedule and hold training scheduling conference at the location where progress meetings are held, to review:
 - a. Training requirements indicated in the Contract Documents.
 - b. Work to be completed prior to commencing training.
 - c. Work progress and Progress Schedule relative to startup and training.
 - d. Scheduling constraints for Owner's and facility manager's personnel, relative to days and times of training sessions.
 - e. Preferred days for training.
 - f. Location where training will be performed and facilities available.
 - g. Required Submittals relative to training.
 - h. Other issues relative to training of operations and maintenance personnel.
2. Attendance is mandatory for the following:
 - a. Contractor's project manager.
 - b. Contractor's Site superintendent.
 - c. Project manager of Subcontractors responsible for furnishing materials and equipment for which training of operations and maintenance personnel is required.
 - d. Suppliers invited by Contractor.
 - e. Engineer.
 - f. Resident Project Representative (RPR).
 - g. Owner's Site Representative (OSR).
 - h. Facility manager's staff responsible for training coordination, and staff responsible for scheduling operations and maintenance personnel.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. Contractor shall prepare minutes summarizing the discussions of conference, decisions made, and agreements and disagreements, and distribute the minutes to each conference attendee and others as appropriate.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Supplier's Instructors:
 - a. Shall be factory-trained by manufacturer of material or equipment.
 - b. Supplier's instructors shall be proficient and experienced in performing training of the types required.
 - c. Instructors shall be proficient, clear, and easily understandable in spoken and written English language.
 - d. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, provide services of replacement instructor with acceptable qualifications.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule Submittals in accordance with time frames specified in this Specifications section.

B. Informational Submittals: Submit the following:

1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply

with requirements of this Specifications section as may be supplemented by Specifications sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Submit lesson plan Submittals in accordance with time frames specified in this Specifications section.

2. Qualifications:
 - a. Credentials of Supplier's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Specifications section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.
 3. Minutes of training scheduling conference.
- C. Closeout Submittals: Submit the following:
1. Trainee sign-in sheets for each training session. Submit to Owner's training coordinator with copy to Engineer.

1.5 LESSON PLAN

- A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be provided, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.
- B. Submit acceptable lesson plan not less than 21 days prior to starting associated training.
- C. Indicate in lesson plan estimated duration of each training segment.
- D. Lesson plan shall include the following:
 1. Material and Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe material and equipment's operating (process) function and performance objectives.
 - b. Describe material and equipment's fundamental operating principles and dynamics.
 - c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
 - d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
 - e. Identify and describe safety precautions and potential hazards related to operation.
 - f. Identify and describe in detail safety and control interlocks.
 2. Operations Personnel Training:
 - a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
 - b. Operation:
 - 1) Describe operating principles and practices.
 - 2) Describe routine operating, startup, and shutdown procedures.
 - 3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.
 - 4) Describe alarm conditions and responses to alarms.
 - 5) Describe routine monitoring and recordkeeping procedures.
 - 6) Describe recommended housekeeping procedures.
 - c. Troubleshooting:
 - 1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.
 3. Mechanical Maintenance Training:
 - a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.

- b. Material and Equipment Preventive Maintenance:
 - 1) Describe preventative maintenance inspection procedures required to:
 - a) Inspect materials and equipment in operation.
 - b) Identify potential trouble symptoms and anticipate breakdowns.
 - c) Forecast maintenance requirements (predictive maintenance).
 - 2) Define recommended preventative maintenance intervals for each component.
 - 3) Describe lubricant and replacement part recommendations and limitations.
 - 4) Describe appropriate cleaning practices and recommend intervals.
 - 5) Identify and describe use of special tools required for maintenance of materials and equipment.
 - 6) Describe component removal, installation, and disassembly and assembly procedures.
 - 7) Perform “hands-on” demonstrations of preventive maintenance procedures.
 - 8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - 9) Define recommended torqueing, mounting, calibrating, and aligning procedures, tolerances, and settings, as appropriate.
 - 10) Describe recommended procedures to check and test equipment following corrective maintenance.
- c. Troubleshooting:
 - 1) Define recommended systematic troubleshooting procedures.
 - 2) Provide component-specific troubleshooting checklists.
 - 3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.
 - 4) Describe common corrective maintenance procedures with “hands-on” demonstrations.
- 4. Instrumentation/Controls and Electrical Maintenance Training:
 - a. Materials and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
 - b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems: Engineer may grant waiver(s) to allow all training for a given system to be at the location of Owner’s training facility.
 - c. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.5.D.3 of this Specifications section.

1.6 TRAINING AIDS

- A. Supplier’s instructor(s) shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:
 - 1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
 - 2. Equipment cutaways and samples, such as spare parts and damaged equipment.
 - 3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.
- B. Handouts:
 - 1. Supplier’s instructor(s) shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
 - 2. Photocopied handouts shall be good quality and completely legible.
 - 3. Handouts shall be coordinated with the instruction, with frequent references made to the handouts.
 - 4. Provide not less than 15 paper copies of each handout for each training session.
- C. Audio-Visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. If suitable equipment is available at the Site, Owner may make available facility’s expiring audio-visual equipment; however, do not count on facility’s expiring audio-

visual equipment, if any, being available. Audio-visual equipment that training provider shall provide, as required, includes:

1. Laptop computer, presentation software, and suitable projector.
2. Power cords, power strips/surge protectors.
3. As required, extension cords, HDMI cables and other video cabling, and spare bulb for projector.
4. Laser pointer/slideshow remote controller with extra batteries.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TRAINING DELIVERY

A. Training Delivery – General:

1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by Engineer, with lesson content appropriate for trainees. If Owner, facility manager, or Engineer deems that training delivery does not comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to Owner.
2. Trainee Sign-in Sheets: In format acceptable to Owner, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name; materials, equipment, or system for which training was provided; and type of training (e.g., operations, mechanical maintenance, instrumentation/controls and electrical maintenance, or other), and full name and operator license number (when applicable) of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated in Article 1.4 of this Specifications section.

B. “Hands-on” Demonstrations:

1. Supplier’s instructor(s) shall present “hands-on” demonstrations of operations and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by Engineer.
2. Contractor and manufacturer shall furnish tools necessary for demonstrations.

3.2 SCHEDULE OF REQUIRED TRAINING

A. Supplier shall provide not less than the hours of training and number of sessions indicated in Table 01 79 23-A of this Specifications Section. Travel time and expenses are responsibility of Supplier and are excluded from required training time indicated in the Contract Documents.

B. Shifts and Training Sessions Required:

1. Operations at the Site take place 24 HRS per day, divided into three shifts as follows: day, evening, and night shift.
2. Training Sessions per Shift:
 - a. Operators: Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days. Provide identical training sessions as follows:
 - 1) Two identical sessions during day shift, each session in a different week.
 - 2) One session during evening shift.
 - 3) One session during night shift.
 - b. Mechanical Maintenance: Provide two identical training sessions during day shift, each session in a separate week, for indicated materials and equipment. Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days.
 - c. Instrument/Controls and Electrical Maintenance: Provide two identical training sessions during day shift, each session in a separate week, for indicated equipment.

Maximum training per day is four hours; sessions longer than four hours will be spread over multiple, preferably consecutive, days.

TABLE 01 79 23-A, TRAINING SUMMARY TABLE

Material or Equipment	Specification Section	Total Training (HRS)	Training Sessions Required		
			Operations	Mechanic Maint.	Instrument/ Controls & Electrical Maint.

END OF SECTION



DIVISION 02

EXISTING CONDITIONS



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SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. General provisions applicable to all demolition and removals.
 - 2. Civil/site demolition and removals.
 - 3. Architectural and structural demolition and removals.
 - 4. Mechanical demolition and removals
 - 5. Electrical demolition and removals.
 - 6. Disposal of demolition debris, materials, and equipment.
- B. Scope:
 - 1. Contractor shall provide all labor, materials, equipment, tools, and incidentals as shown, specified and required for demolition, removals, and disposal Work.
 - 2. The Work under this Specifications section includes, but is not necessarily limited to:
 - a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, pavement, curbs, sidewalks, gutters, fencing, and similar existing materials, equipment, and items.
 - 3. Demolitions and removals indicated in other Specifications sections shall comply with requirements of this Specifications section.
 - 4. Perform demolition Work within areas shown or indicated.
 - 5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition and removals Work.
- C. Related Requirements:
 - 1. Section 31 10 00 - Site Clearing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Fire Protection Association (NFPA):
 - a. 241, Safeguarding Construction, Alteration, and Demolition Operations.
- B. Regulatory Requirements:
 - 1. Demolition, removals, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T – Demolition), and all other Laws and Regulations.
 - 2. Comply with requirements of authorities having jurisdiction.
- C. Qualifications:
 - 1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician(s) legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.
 - 2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber(s) legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Review procedures under this and other Specifications sections and coordinate the Work that will be performed with or before demolition and removals.

1.4 SUBMITTALS

- A. Informational Submittals: Submit the following:
1. Procedure Submittals:
 - a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
 - 1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
 - 2) Other proposed procedures as applicable.
 - 3) Equipment proposed for use in demolition operations.
 - 4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
 - 5) Planned demolition operating sequences.
 - 6) Detailed schedule of demolition Work in accordance with the Schedule accepted by Engineer.
 2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.
 3. Field Quality Control Test Results:
 - a. Results of megger-testing of existing motors to remain Owner's property.
 4. Qualifications Statements:
 - a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.
 - b. Name and qualifications of entity performing plumbing removals,

1.5 SITE CONDITIONS

- A. Owner makes no representation of condition or structural integrity of area(s) to be demolished or where removals are required by the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Notification:
1. Not less than 48 HRS prior to commencing demolition or removal, advise Engineer in writing of planned start of demolition Work. Do not start removals without permission of Engineer.
 2. Where demolition or removals has potential to affect adjacent properties, occupants, streets, or other public thoroughfare, transportation facilities, and utilities, furnish required notices to owners and occupants of properties, buildings, and structures that may be affected by the demolition of removal.
 3. In accordance with Laws and Regulations, furnish to authorities having jurisdiction, including emergency services as necessary, appropriate notices of planned demolition and removals.
 4. Submit to Engineer copies of notices furnished to adjacent property owners, occupants, and authorities having jurisdiction.
- B. Protection of Adjacent Areas and Facilities:
1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties unless allowed by the Contract Documents otherwise allowed in writing by Owner.
 2. Provide appropriate temporary barriers, lighting, sidewalk sheds, and other necessary protection.

3. Repair damage to facilities that are to remain which such damages results from Contractor's operations.
- C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, perform the following:
 1. Should unforeseen, unknown, or incorrectly shown or indicated Underground Facilities be encountered, Contractor responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
 2. Storm Water Sewerage: Existing storm water system shall remain in place until demolition of existing building or structure is complete. Upon completing demolition, cut and cap storm sewerage at locations shown on the Drawings. Remove existing storm water piping and related structures between points of cutting, and backfill, restore to grade, and stabilize the area over the removed facilities in accordance with the Contract Documents.
 3. Water Piping and Related Facilities: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished. Ensure compliance with Laws and Regulations regarding water quality.
 4. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; compressed air; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
 5. Shutdown of utility services shall be coordinated by Contractor, assisted by Owner as required relative to contacting utility owners.
- D. Remediation:
 1. If unanticipated Hazardous Environmental Condition is believed to be encountered during demolition and removals, comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions.

3.2 DEMOLITION - GENERAL

- A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.
- B. Pollution Controls:
 1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level.
 2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
 3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions and Section 01 74 23 - Cleaning.
- C. Explosives:
 1. Explosives are not allowed at the Site. Do not use explosives for demolition and removal Work.
- D. Comply with Section 01 73 29 - Cutting and Patching and NFPA 241.
- E. Building or Structure Demolition and Removals:
 1. Unless otherwise approved by Engineer, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
 2. Demolish concrete and masonry in small sections.
 3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
 4. Break up and remove foundations, mats, and slabs-on-grade unless otherwise shown or indicated as remaining in place.

5. Temporary Bracing and Supports:
 - a. Provide temporary bracing and supports sufficient to maintain safety, stability, and resist all loads to which the structure may be subject during demolition and removals, until entirety is permanently removed or permanently stabilized.
 - b. Temporary bracing and supports shall be sufficient for associated dead load, live load, transient loading, and dynamic loads such as wind, seismic, and other loads to which the temporary bracing or support may be subject.
 - c. Where appropriate, retain a professional structural engineer, duly licensed and registered in the same jurisdiction as the Site, to design temporary bracing and supports.
- F. Salvage and Ownership:
 1. Materials and equipment to remain Owner's property shall be:
 - a. Carefully removed and appropriately handled by Contractor to avoid damage and invalidation of warranties in effect. Brace motors attached to flexible mountings until reinstallation or delivery to Owner's storage location. Fully remedy to pre-construction condition or replace items damaged during removal or handling by Contractor.
 - b. Removed as functional units, together with all appurtenances required for operation.
 - c. Cleaned, listed, and tagged for storage.
 - d. Protected from damage.
 - e. Delivered to designated storage location at the Site or other site indicated in the Contract Documents, at place designated by Engineer or Owner.
 2. Items to be and delivered to Owner are as indicated in Table 02 41 00-A.

Table 02 41 00-A – Items to be Salvaged

Equipment Name/ Designation	Equipment Location	Deliver to Owner's Location

3. Preparation of Owner's existing equipment for storage:
 - a. Where appropriate, identify each component with markings or tags to indicate its position in the assembly and the assembly of which it is part.
 - b. Place small parts in appropriate, durable boxes and clearly mark contents on the outside of box or container.
 - c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
 - d. Grease grease-lubricated bearings.
 - e. Replace breather plugs with solid plugs.
 - f. Megger-test motor windings: Attach report of the test results to the associated motor and submit copy to Engineer.
 - g. Attach unit to suitable crate bottom.
 - h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.
 - i. Construct crate of wood slats around top and sides of unit.
 - j. Attach permanent instruction tag to outside of crate stating "This unit has been prepared for storage. Replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up."
- G. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by Engineer.

3.3 STRUCTURAL REMOVALS

- A. Remove structures to lines and grades shown or indicated, unless otherwise directed by Engineer. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at Contractor's risk and expense and such excess removals shall be reconstructed to satisfaction of Engineer without additional cost to Owner.
- B. Recycling and Reuse of Demolition Materials:
 - 1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by Engineer.
 - 2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.
- C. After removing concrete and masonry walls or portions thereof, mats, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.
- D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
 - 1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
 - 2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
 - 3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 IN below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
 - 4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.
- E. Removal of Anchorages and Protruding Metals:
 - 1. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, and where existing metals (and to be removed) protrude from concrete, remove the anchors and other metal to not less than 1.5 IN beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface.
 - 2. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by Engineer.
- F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.
- G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Specifications section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

- A. Mechanical demolition and removal Work includes dismantling and removing existing:
 - 1. Piping systems and ductwork systems.
 - 2. Mechanical equipment and appurtenances.
 - 3. Mechanical elements of instrumentation and control systems, such as sensors and transmitters and similar items.

4. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 73 29 - Cutting and Patching; Specifications sections in which requirements for coordination with Owner's operations are indicated; and applicable Specifications of Division 21 - Fire Suppression, Division 22 - Plumbing, Division 23 - Heating, Ventilating, and Air Conditioning, Division 40 - Process Interconnections, and others as applicable.
 5. Mechanical removals as required herein apply to systems exposed to view, hidden from view, and Underground Facilities. Mechanical removals may require work in spaces that may be classified confined spaces.
- B. Life-Safety Systems:
1. Retain existing life-safety systems, including but not limited to fire suppression systems, in place for as long as possible prior to performing associated demolition and removals.
 2. Where demolishing buildings or structures equipped with life-safety systems, remove or deactivate life-safety systems only in the area where active demolition operations are in progress.
- C. Demolition and Removals of Piping, Ductwork, and Similar Items:
1. Scope:
 - a. Safety purge piping and tanks (as applicable) of chemicals, fuel, solids, liquids, and gases (as applicable) and make safe for removal and capping. Discharge contents of existing piping appropriately while avoiding damaging property; restricting access to or use of property; and cresting unsafe, unsanitary, nuisances, and noisome conditions.
 - b. To the extent shown or indicated, remove existing piping conveying water (potable and non-potable), waste and vent, fuel (liquids and gases), heating fluids (such as water-glycol solutions), chemicals, solids and slurries, sludge, wastewater, other fluids, and processes gases, and other piping.
 - c. Remove piping to the nearest structurally sound (or "solid") piping support, and provide caps on ends of remaining piping.
 - d. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
 2. Caps, Closures, Blind Flanges, and Plugs – General (All Piping and Ducts):
 - a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
 - b. Where used in this Specifications section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
 - c. Caps shall be compatible with the piping or ductwork on which the cap is installed, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
 - d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Specifications section only when expressly so shown or indicated in the Contractor Documents or when allowed by Engineer.
 3. Underground Facilities:
 - a. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.
 4. Waste and Vent Piping; Ductwork:
 - a. Remove waste and vent piping, and ductwork to extent shown and cap as required.
 - b. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials as existing, and fully compatible with ensign materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
 5. Potable Water Piping; Plumbing; Fire Suppression Piping and Systems; Heating Piping:
 - a. Modifications to potable water piping, fire suppression systems, other plumbing piping, and heating system piping shall comply with Laws and Regulations.

- b. All portions of potable water systems that have been modified or opened shall be hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing and fire suppression piping and heating piping systems.

3.5 ELECTRICAL REMOVALS

- A. Electrical demolition Work includes removing existing:
 - 1. Disconnecting cabling from motors, electrical sources, control panels, control stations, instrumentation and control items, and similar devices and equipment.
 - 2. Conduits, raceways, cable trays, hangers and supports, cabling, and related items.
 - 3. Switches, panelboards, control stations, and similar items.
 - 4. Transformers, distribution switchboards, control panels, motors, starters, variable speed controllers, and similar items.
 - 5. Lighting fixtures and related items.
 - 6. Utility poles, site lighting standards, and overhead cabling.
 - 7. Appurtenances and miscellaneous electrical equipment, as shown, specified, or required.
- B. Electrical Removals – General:
 - 1. Comply with Laws and Regulations, including the National Electric Code.
 - 2. Lock Out and Tagging:
 - a. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cabling are de-energized to ground potential before commencing electrical removals Work.
 - b. Upon completion of electrical removals Work, remove the locks and tags and promptly advise Resident Project Representative (RPR) or Engineer and Owner that existing facilities are available for use.
 - 3. Remove existing electrical equipment, fixtures, and systems to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
 - 4. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated.
 - 5. Store removed motors, microprocessors and electronics, and other electrical gear to be reused in accordance with its manufacturer's recommendations and requirements of the Contract Documents.
- C. Motor Control Centers and Switchgear:
 - 1. Remove or modify motor control centers and switchgear as shown or indicated.
 - 2. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.
- D. Removal of Cabling, Conduits, Raceways and Similar Items:
 - 1. Verify the function of each cable before disconnecting and removing.
 - 2. Remove cabling, conduits, hangers and supports, and similar items back to the power source or control panel, unless otherwise shown or indicated.
 - 3. Remove cabling, conduits, and similar items where shown or indicated for removal. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to Engineer.
 - 4. Disassemble and remove exposed conduits, junction boxes, other electrical appurtenances, and their supports.
 - 5. Repair all areas of the Work to prevent rusting on exposed surfaces.
 - 6. Underground Electric:
 - a. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
 - b. Where shown or indicated, remove direct-burial cabling. Openings in buildings for entrance of direct-burial cabling shall be patched with repair mortar or other material approved by Engineer for such purpose, and made watertight.

- E. Electrical Service Entrances and Outdoor, Overhead Electrical Utilities:
 - 1. Existing poles and overhead cabling shall be removed or abandoned as shown and specified.
 - 2. Completely remove from the Site poles not owned by electric utility, including site lighting standards and appurtenances, shown or indicated for removal.
 - 3. Existing substation(s) and poles owned by electric utility will be removed by the electric utility.
 - 4. Make necessary arrangements with electric utility owner for removal of utility owner's transformers and metering equipment after new electrical system has been installed and energized.
- F. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as Owner's property, shall be removed and properly disposed off-Site as required in accordance with Laws and Regulations.

3.6 DEMOLITION OF SITE IMPROVEMENTS

- A. Pavement, Sidewalks, Curbs, and Gutters:
 - 1. Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
 - 2. To cut pavement, sidewalks, curbs, and gutters, use machinery or tools that provides a smooth-cut edge, appropriate for the required. Where cut edges are not smooth, repair the cut edge to remain to provide a smooth, even appearance.
- B. Fencing, Guardrails, and Bollards:
 - 1. Remove to the limits shown or indicated on the Drawings.
 - 2. Completely remove below-grade posts and concrete.
- C. Manholes, Vaults, Chambers, and Handholes:
 - 1. Remove to the limits shown or indicated on the Drawings.
 - 2. If not shown or indicated on the Drawings, remove to not less than three feet below finished grade indicated on the Drawings.
- D. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes:
 - 1. Remove to the extent shown or indicated on the Drawings.
 - 2. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Specifications section.
- E. Landscaping: Comply with Section 31 10 00 - Site Clearing.
- F. Other Site Improvements: When the Contract Documents require removal of other site improvements not addressed above, copy with Contract requirements for removal of buildings or structures.

3.7 DISPOSAL OF DEMOLITION DEBRIS

- A. Disposal – General:
 - 1. Promptly remove from the Site all debris, waste, rubbish, material, and equipment resulting from demolition and removal operations. Promptly upon completion of demolition and removal operations, remove from the Site construction equipment used in demolition Work.
 - 2. Do not sell at the Site demolition materials or removed equipment. If materials, equipment or debris will be sold by Contractor, remove the items from the Site and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.
 - 3. Cleaning and Removal of Debris: Comply with the General Conditions, Supplementary Conditions, and Section 01 74 23 - Cleaning.
- B. Transportation and Disposal:
 - 1. Non-Hazardous Materials, Equipment, and Debris: Properly transport and dispose of non-hazardous demolition materials, equipment, and debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Constituents of Concern such as (but not limited to) asbestos, PCBs, petroleum,

hazardous waste, radioactive material, or other material designated as hazardous in Laws or Regulations.

- C. Submit to Engineer information required in this Specification Section on proposed facility(ies) where demolition materials, equipment, and debris will be recycled. Upon request, Engineer or Owner, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist Engineer and Owner.

END OF SECTION

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DIVISION 03

CONCRETE



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SECTION 03 05 05
CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Contractor requirements for testing of concrete and grout.
 - 2. Definition of Owner provided testing.
 - 3. Acceptance criteria for concrete.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 21 00 - Reinforcement.
 - 4. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
 - 6. Section 03 41 33 - Precast and Prestressed Concrete.

1.2 RESPONSIBILITY AND PAYMENT

- A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
 - 1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
 - 2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
 - 3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
 - 4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
 - 5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
 - 6. Owner will pay for services defined in Paragraph 1.2A.1.
- B. Hire a qualified testing agency to perform the following testing and provide test results to the Engineer.
 - 1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
 - 2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
 - 3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
 - 4. Reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
- C. Duties and Authorities of Testing Agency/Service Provider:
 - 1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
 - 2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
 - 3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.

- a. All test reports to include exact location in the work at which batch represented by a test was deposited.
- b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
- 4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete.
 - 2. ASTM International (ASTM):
 - a. ASTM Cement and Concrete Reference Laboratory (CCRL).
 - b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. C94, Standard Specification for Ready-Mixed Concrete.
 - f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
 - h. C1019, Standard Test Method for Sampling and Testing Grout.
 - i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- B. Qualifications:
 - 1. Contractor's Testing Agency:
 - a. Meeting requirements of ASTM E329 and ASTM C94.
 - b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.
- C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

- A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Concrete materials and concrete mix designs proposed for use.
 - 1) Include results of all testing performed to qualify materials and to establish mix designs.
 - 2) Place no concrete until approval of mix designs has been received in writing.
 - 3) Submittal for each concrete mix design to include:
 - a) Sieve analysis and source of fine and coarse aggregates.
 - b) Test for aggregate organic impurities.
 - c) Proportioning of all materials.
 - d) Type of cement with mill certificate for the cement.

- e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.
 - f) Slump.
 - g) Brand, type and quantity of air entrainment and any other proposed admixtures.
 - h) Shrinkage test results.
 - i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
 - j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.
3. Certifications:
- a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

- A. The following concrete testing will be performed by the Service Provider/Testing Agency:
- 1. Concrete strength testing:
 - a. Secure concrete samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
 - b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
 - 1) Record any deviations from requirements on test report.
 - 2) Cylinder size: Per ASTM C31.
 - a) 4 IN cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 IN.
 - b) Use the same size cylinder for all tests for each concrete mix.
 - 3) Quantity:
 - a) 6 IN DIA by 12 IN high: Four cylinders.
 - b) 4 IN DIA by 8 IN high: Six cylinders.
 - c. Field cure one cylinder for the seven day test.
 - 1) Laboratory cure the remaining.
 - d. Test cylinders in accordance with ASTM C39.
 - 1) 6 IN DIA cylinders:
 - a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
 - b) Hold remaining cylinder in reserve.
 - 2) 4 IN DIA cylinders:
 - a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
 - b) Hold remaining cylinders in reserve.
 - e. Strength test result:
 - 1) Average of strengths of two, 6 IN DIA cylinders or three, 4 IN DIA cylinders from the same sample tested at 28 days.
 - 2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
 - 3) Should all cylinders in any test show any of above defects, discard entire test.

- f. Frequency of tests:
 - 1) Concrete sand cement grout: One strength test for each 4 HR period of grout placement or fraction thereof.
 - a) Test grout in accordance with ASTM C1019.
 - 2) Concrete topping, concrete fill and lean concrete: One strength test for each 60 CUYD of each type of concrete or fraction thereof placed.
 - 3) Precast concrete: Frequency per Specification Section 03 41 33.
 - 4) All other concrete:
 - a) One strength test to be taken not less than once a day, nor less than once for each 60 CUYD or fraction thereof placed in any one day.
 - b) Once for each 5000 SQFT of slab or wall surface area placed each day
 - c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.
- 2. Slump testing:
 - a. Determine slump of concrete sample for each strength test.
 - 1) Determine slump in accordance with ASTM C143.
 - b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
 - 1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
- 3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231, ASTM C173, or ASTM C138.
- 4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

- A. See Section 01 45 23.
 - 1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
 - 2. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
- B. Formwork Special Inspections:
 - 1. Shape, location, and dimensions.
 - a. Inspect in accordance with dimensions and details on Drawings.
 - b. Frequency: Inspect prior to each concrete pour.
- C. Reinforcing Special Inspections:
 - 1. Reinforcing size, spacing, lap length and concrete cover.
 - a. Inspect in accordance with Drawings and Specification.
 - b. Frequency: Inspect prior to each concrete pour.
 - 2. Reinforcing adhesive anchoring system:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all adhesive anchors for the first 4 HRS of installation.
 - 2) Inspect approximately 25 PCT of adhesive anchors thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
 - 3. Mechanical splices:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all mechanical splices prior to placing concrete .
 - 2) Inspect approximately 25 PCT of mechanical splices thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

- D. Mixing, Placing, Jointing, and Curing Special Inspections:
 - 1. Perform concrete tests per the requirements of this Specification Section.
 - 2. Verification of proper mix design.
 - a. Frequency: Periodically, prior to each concrete pour.
 - 3. Proper concrete placement techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: During each concrete pour.
 - 4. Proper curing temperature and techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: Periodically, but not less than every third day.
 - 5. Joints:
 - a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
 - b. Frequency: Prior to each concrete pour.
 - 6. Waterstops:
 - a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
 - b. Frequency:
 - 1) Prior to each concrete pour.
- E. Anchorage to Concrete Special Inspection:
 - 1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
 - a. Frequency: Per ICC-ES Report.
 - 2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
 - a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

- A. To facilitate testing and inspection, perform the following:
 - 1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
 - 2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.
 - 3. Take samples at point of placement into concrete member.
- B. Notify Engineer and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

- A. Completed concrete work which meets applicable requirements will be accepted without qualification.
- B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
- C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
 - 1. In this event, modifications may be required to assure that concrete work complies with requirements.
 - 2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.
- D. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.

2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
 - a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
 3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
 4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
 - a. Repair or remove and replace if required.
 5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
 - a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.
- E. Appearance:
1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
 2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.
- F. High Water-Cement Ratio:
1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
 2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.
- G. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
 - a. Low concrete strength:
 - 1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
 - a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
 - b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
 - c) A strength test shall be the average of two, 6 IN diameter cylinders or three, 4 IN diameter cylinders from the same sample tested at 28 days.
 - 2) Acceptance:
 - a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
 - (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
 - (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 PSI.
 - b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.
 - c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
 - d. Curing time and procedure not meeting requirements of this Specification Section.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

- f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
- 2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
- 3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
 - a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
 - 1) Such tests shall not be used as a basis for acceptance or rejection.
 - b. Core tests:
 - 1) Where required, test cores will be obtained in accordance with ASTM C42.
 - a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DEGF, relative humidity less than 60 PCT) for seven days before test then test dry.
 - b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
 - c) Testing wet or dry to be determined by Engineer.
 - 2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
 - a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
 - b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
 - 3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85 PCT of specified strength and no single core is less than 75 PCT of specified strength.
 - 4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
- 4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
- 5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
- 6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

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SECTION 03 11 13

FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formwork requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 05 05 - Concrete Testing and Inspection.
 - 4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - 5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 347R, Guide to Formwork for Concrete.
- B. Qualifications:
 - 1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
 - a. Above qualifications apply to slabs and beams not cast on the ground.
- C. Miscellaneous:
 - 1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
 - 2. Design requirements:
 - a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
 - 1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
 - b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
 - 3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores and installation of reshores and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
 - a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon. Calculations shall be performed by a licensed professional engineer.
 - b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
 - 1) The structural system that exists.
 - 2) Effects of all loads during construction.
 - 3) Strength of concrete.
 - 4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.

- 5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
- 6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for the requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Manufacturer and type of proposed form ties.
- B. Samples:
1. A 12 IN SQ sample of each of the following form finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms for Surfaces Exposed to View:
1. Wood forms:
 - a. 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
 - b. Built-in-place or prefabricated type panel.
 2. Metal forms:
 - a. Metal forms may be used except for aluminum in contact with concrete.
 - b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.
- B. Forms for Surfaces Not Exposed to View:
1. Wood or metal sufficiently tight to prevent leakage.
 2. Do not use aluminum forms.

2.2 ACCESSORIES

- A. Form Ties:
1. Commercially fabricated for use in form construction.
 - a. Field fabricated ties are unacceptable.
 2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
 3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
 4. Cone size:
 - a. 3/4 IN minimum diameter cones on both ends.
 - b. Depth of cone not to exceed the concrete reinforcing cover.
 5. Provide ties with built-in waterstops in all walls that will be in contact with process liquid during plant operation below grade soil]
 6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with process liquid during plant operation.
- B. Void Forms:
1. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
 2. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Form Surface Treatment:
 - 1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
 - a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
 - 2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.
- B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
 - 1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.
- C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

- A. Install products in accordance with manufacturer's instructions.
- B. Tolerances:
 - 1. Conform to ACI 117.
 - 2. Variation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in risers.
 - 1) Maximum in any 10 FT of height: 1/4 IN.
 - 2) Maximum for entire height: 1/2 IN.
 - b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
 - 1) Maximum in any 20 FT length: 1/4 IN.
 - 2) Maximum for entire length: 1/2 IN.
 - 3. Variation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
 - 1) Maximum in any 10 FT of length: 1/4 IN.
 - 2) Maximum in any bay or in any 20 FT length: 3/8 IN.
 - 3) Maximum for entire length: 3/4 IN.
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
 - 1) Maximum in any bay or in 20 FT length: 1/4 IN.
 - 2) Maximum for entire length: 1/2 IN.
 - 4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
 - a. Maximum in any bay: 1/2 IN.
 - b. Maximum in any 20 FT of length: 1/2 IN.
 - c. Maximum for entire length: 1 IN.
 - 5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
 - 6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.
 - 7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.
 - 8. Footings and foundations:
 - a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
 - b. Misplacement or eccentricity:

- 1) 2 PCT of footing width in direction of misplacement but not more than 2 IN.
- c. Thickness:
 - 1) Decrease in specified thickness: 5 PCT.
 - 2) Increase in specified thickness: No limit except that which may interfere with other construction.
9. Variation in steps:
 - a. In a flight of stairs:
 - 1) Rise: +1/8 IN.
 - 2) Tread: +1/4 IN.
 - b. In consecutive steps:
 - 1) Rise: +1/16 IN.
 - 2) Tread: +1/8 IN.
10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.
- C. Make forms sufficiently tight to prevent loss of mortar from concrete.
- D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.
- E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
 1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
 2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.
- F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.
 1. Brace and tie formwork to maintain correct position and shape of members.
- G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.
- H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.
- I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.
- J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
 1. Securely brace forms against lateral deflection.
 2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

- C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
 - 1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.
- D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.
- E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
- F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28 day compressive strength.
 - 1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.
- G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.
- C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.
- D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.
- E. Tighten reshores to carry their required loads without overstressing.
- F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.
- G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
 - 1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
 - 2. Locate reshores directly under a shore position above.
- H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.5 FIELD QUALITY CONTROL

- A. Special Inspection:
 - 1. See Section 01 45 23.
 - 2. See Section 03 05 05.

END OF SECTION

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SECTION 03 15 19
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing anchorage adhesive, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
 2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
 - a. Structural members and accessories.
 - b. Metal, wood, and plastic fabrications.
 - c. Architectural components.
 - d. Mechanical and electrical equipment and components.
 - e. Plumbing, piping, and HVAC work.
 - f. All other components requiring attachment to concrete.
- B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
 2. Division 01 - General Requirements.
 3. Section 03 05 05 - Concrete Testing and Inspection.
 - 4.
 5. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete and Commentary.
 2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
 - a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
 3. American Institute of Steel Construction (AISC):
 - a. 303, Code of Standard Practice for Steel Buildings and Bridges.
 - b. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
 - c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
 4. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - i. F436, Standard Specification for Hardened Steel Washers.
 - j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - k. F594, Standard Specification for Stainless Steel Nuts.

- l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- 5. ICC Evaluation Service (ICC-ES):
 - a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- B. Qualifications:
 - 1. Anchor designer for Contractor-designed post-installed anchors and cast in place anchorage shall be a professional civil engineer licensed in the State that the Project is located in.
 - 2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
- C. Post-installed anchors and related materials shall be listed by the following agencies:
 - 1. ICC-ES.
 - 2. Engineer approved equivalent.

1.3 DEFINITIONS

- A. Adhesive Anchors:
 - 1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
 - 2. Includes anchors using acrylics, epoxy and other similar adhesives.
- B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.
- C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.
- D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.
- E. Galvanizing: Hot-dip galvanizing per ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
- F. Hardware: As defined in ASTM A153.
- G. Installer or Applicator:
 - 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 - 2. Installer and applicator are synonymous.
- H. MPPI: Manufacturer's printed installation instructions.
- I. Mechanical Anchors:
 - 1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
 - 2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
 - 3. Drop-in anchors and other similar non-ICC ES approved anchors are not allowed.
- J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that submitted products meet requirements of referenced standards.
 - b. Manufacturer material data sheet for each anchor.

- 1) Clearly indicate which products on the data sheet are proposed for use on the Project.
 - c. Manufacturer's printed installation instructions.
 - d. Current ICC-ES report for each post-installed anchor system indicating the following:
 - 1) Certification that anchors meet all requirements indicated in this Specification.
 - 2) Performance data showing that anchor is approved for use in cracked concrete.
 - 3) Seismic design categories for which anchor system has been approved.
 - 4) Required installation procedures.
 - 5) Special inspection requirements for installation.
 - e. Anchorage layout drawings and details:
 - 1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
 - 2) Drawings showing location, configuration, spacing and edge distance.
 - f. Contractor Designed Post-Installed Anchors:
 - 1) Show diameter and embedment depth of each anchor.
 - 2) Indicate compliance with ACI 318, Appendix D ACI 318, Chapter 17.
 - 3) Design tension and shear loads used for anchor design.
 - 4) Engineering design calculations:
 - a) Indicate design load to each anchor.
 - b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
 - c) Sealed and signed by contractor's professional engineer.
 - d) Calculations will be submitted for information purposes only.
 - 5) Type of post-installed anchor system used.
 - a) Provide manufacturer's ICC-ES report for the following:
 - (1) Mechanical anchorage per ICC-ES AC193.
 - (2) Adhesive anchorage per ICC-ES AC308.
- B. Samples:
1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Contractor.
- C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Certification of qualifications for each installer of post-installed anchors.
 - a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.
 - b. Provide one of the following for each type of anchor, as required by this specification section:
 - 1) Letter from manufacturer documenting successful training completion for mechanical anchors only.
 - 2) Certification of completion for Engineer approved program.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to job site in manufacturer's or distributor's packaging undamaged and complete with installation instructions.
- B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.
- C. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cast-in-place Concrete Anchors:
 - 1. Building, nonbuilding structures, and equipment, unless otherwise specified:
 - a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized or non-galvanized threaded rods.
 - b. ASTM A307, Grade A for galvanized headed bolts.
 - 2. All other cast-in-place concrete anchors:
 - a. Stainless steel with matching nut and washer.
 - b. Submerged application: ASTM F593, Type 316.
 - c. Non-submerged application: ASTM F593, Type 304 or Type 316.
- B. Post-Installed Mechanical and Adhesive Concrete Anchors:
 - 1. Stainless steel with matching nut and washer.
 - 2. Submerged application: ASTM F593, Type 316.
 - 3. Non-submerged application: ASTM F593, Type 304 or Type 316.
- C. Reinforcement: See Section 03 21 00.
- D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.
- E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.
- F. Washers:
 - 1. ASTM F436 unless noted otherwise, finish to match bolt.
 - 2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
 - 3. Plate washers: Minimum 3/4 IN thick fabricated ASTM A36 square plates as specified or required.
 - 4. Follow manufacturer's requirements for all post-installed anchorage.
- G. Nuts:
 - 1. ASTM A563 for all cast-in-place anchorage.
 - 2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
 - 3. Follow manufacturer's requirements if using post-installed anchorage.
- H. Galvanizing Repair Paint:
 - 1. High zinc dust content paint for regalvanizing welds and abrasions.
 - 2. ASTM A780.
 - 3. Zinc content: Minimum 92 PCT in dry film.
 - 4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."
- I. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.2 CONTRACTOR DESIGNED ANCHORAGE

- A. Manufacturers:
 - 1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Engineer.
 - a. Hilti.
 - b. Dewalt.
 - c. Simpson Strong-Tie.
 - 2. Submit request for substitution in accordance with Specification Section 01 25 00.
- B. Design the anchorage when any of the following occur:

1. Design load for concrete anchorage is shown on the Drawings.
 2. When specifically required by the Contract Documents.
 3. When an anchorage is required but not specified in the Drawings.
 4. When anchorage is shown on Drawings other than Structural Drawings.
- C. Anchorage Design Loads:
1. Determine all of the design loads, including wind and seismic loads, per the building code.
 - a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.
- D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Contractor design shall incorporate these as “minimums.”
- E. Cast-in-Place Concrete Anchors:
1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the building code including ACI 318, Appendix D, ACI 318, Chapter 17.
 2. Design assuming cracked concrete.
- F. Post-installed Concrete Anchors:
1. Provide the manufacturer’s system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified [or calculated] load based on requirements given in the building code, ACI 318, Appendix D, ACI 318, Chapter 17 and current ICC-ES report, for the anchor to be used.
 2. Design assuming cracked concrete.

2.3 ENGINEER DESIGNED ANCHORAGE

- A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required unless otherwise indicated.
- B. Manufacturers:
1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by the Engineer.
 2. Mechanical Anchors:
 - a. Hilti:
 - 1) Kwik Bolt TZ (ICC-ES ESR-1917).
 3. Adhesive Concrete Anchors:
 - a. Hilti:
 - 1) HIT RE 500 V3 (ICC ESR-3814).
 4. Concrete Screw Anchors:
 - a. Hilti:
 - 1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
 5. Submit request for substitution in accordance with Specification Section 01 25 00.
 - a. Substitution request to indicate the proposed anchor has the at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
 - b. Calculations to be stamped by a Professional Engineer registered in the state that the Project is located in.

PART 3 - EXECUTION

3.1 GENERAL

- A. Cast-in-Place Anchorage:
1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.

2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.
- B. Adhesive Anchorage:
 1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
 2. May be used where subjected to vibration or where buried or submerged.
 3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
 4. Contact Engineer for approval when anchors will not be installed in compliance with MPII
- C. Mechanical Anchorage:
 1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
 2. Do not use where subjected to vibration.
 3. May be used in overhead applications.
 4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.
- D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

3.2 PREPARATION

- A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.
- B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
 1. Notify Engineer of conditions detrimental to proper and timely completion of work.
 2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
- C. Special Inspection is required in accordance with the building code for all concrete anchorage.
 1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
 2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.
- D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.
 1. Follow such procedures to assure acceptable installation.
 2. Adhesive anchors must be installed in concrete aged a minimum of 21 days.

3.3 INSTALLATION

- A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
 1. Tack welding of anchorage is prohibited.
 2. Chase threads as required and coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
 3. Anchorage location tolerance shall be in accordance with AISC 303.
 4. Provide steel or durable wood templates for all column and equipment anchorage.
 - a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.
- B. Unless noted or specified otherwise:
 1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
 - a. Provide dissimilar materials protection per Specification Section 09 96 00.
 2. Provide washers for all anchorage.

3. Where exposed, extend threaded anchorage a minimum of 1/2 IN above the top of the fully engaged nut.
 - a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.
- C. Do the following after nuts are snug-tightened down:
 1. If using post-installed anchorage, follow MPII.
 2. Upset threads of anchorage to prevent nuts from backing off.
 - a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
 3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn beyond snug tight to prevent nuts from backing off.
 4. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two nuts together.
 5. If using post-installed anchorage, follow MPII.
- D. Assure that embedded items are protected from damage and are not filled in with concrete.
- E. Secure architectural components such that it will not be aesthetically distorted and fasteners will not be overstressed from expansion, contraction, or installation.
- F. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.
- G. Repair damaged galvanized surfaces in accordance with ASTM A780.
 1. Prepare damaged surfaces by abrasive blasting or power sanding.
 2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.
- H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
 1. Use hammer drills to create holes.
 2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

- A. Special Inspection:
 1. See Section 01 45 23.
 2. See Section 03 05 05.
- B. Field Inspection and Testing
 1. Owner reserves the right to inspect and test completed anchorage at a minimum of 10% (for large quantity) to 25% (smaller quantity) to 100% (very small project quantity).
 2. Such testing shall conform to requirements of ACI 355.2 and/or ACI 355.4 as applicable.
 3. Failed anchors shall be satisfactorily replaced at no cost to Owner.

3.5 CLEANING

- A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.
- B. Provide surface acceptable to receive field applied paint coatings when specified in Specifications.

END OF SECTION

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SECTION 03 21 00

REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reinforcing bar requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 05 05 - Concrete Testing and Inspection.
 - 4. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. SP 66, ACI Detailing Manual.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - d. 318, Building Code Requirements for Structural Concrete.
 - 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
 - f. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 3. Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Standard Practice.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Mill certificates for all reinforcing.
 - d. Manufacturer and type of proprietary reinforcing mechanical splices.
 - 3. Qualifications of welding operators, welding processes and procedures.
 - 4. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
 - 5. Sufficient reinforcing details to permit installation of reinforcing.
 - 6. Reinforcing details in accordance with ACI SP 66 and ACI 315.
 - 7. Locations where proprietary reinforcing mechanical splices are required or proposed for use.

8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
 - a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
 - b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Support and store all reinforcing above ground.
- B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Reinforcing adhesive anchors:
 - a. See Specification Section 03 15 19.
 2. Reinforcing mechanical splices:
 - a. Lenton Rebar Splicing by Erico, Inc.
 - b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
 - c. Bar-Grip Systems by Barsplice Products, Inc.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Reinforcing Bars: ASTM A615, grade 60, deformed.
- B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.
- C. Welded Wire Reinforcement: ASTM A1064 .
- D. Smooth Dowel Bars:
 1. Water containing structures: ASTM A276, Type 316.
 2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.
- E. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125 PCT of the yield strength of the reinforcing bars being spliced.
- F. Headed Deformed Bars:
 1. ASTM A970, Class A.
- G. Reinforcing Adhesive Anchors:
 1. See Specification 03 15 19.

2.3 ACCESSORIES

- A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
 1. Metal fabrications with plastic-coated tips in contact with forms.
 - a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
 2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
 - a. 100 PCT non-metallic, non-corrosive.
 - b. Required for all walls and elevated construction exposed to liquid containing structures.
- B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

- A. Tolerances:
 - 1. Conforms to ACI 117, except as modified herein.
 - 2. Sheared lengths: +1 IN.
 - 3. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
 - 4. All other bends: +0 IN, -1/2 IN.
- B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.
- C. Ship reinforcing to jobsite with attached plastic or metal tags.
 - 1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
 - 2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Tolerances:
 - 1. Conform to ACI 117, except as modified herein.
 - 2. Reinforcing placement:
 - a. Clear distance to formed surfaces: +1/4 IN.
 - b. Minimum spacing between bars: -1/4 IN.
 - c. Top bars in slabs and beams:
 - 1) Members 8 IN deep or less: +1/4 IN.
 - 2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
 - 3) Members more than 2 FT deep: -1/4 IN, +1 IN.
 - d. Crosswise of members: Spaced evenly within +1 IN.
 - e. Lengthwise of members: +2 IN.
 - 3. Minimum clear distances between reinforcing bars:
 - a. Beams, walls and slabs: Distance equal to bar diameter or 1 IN, whichever is greater.
 - b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 IN, whichever is greater.
 - c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.
- B. Minimum concrete protective covering for reinforcement: As shown on Drawings.
- C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
 - 1. For reinforcing: Class B splice meeting the requirements of ACI 318.
 - 2. For welded wire reinforcement:
 - a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
 - b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318].
 - 3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
 - a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.
- D. Welding:
 - 1. Welding reinforcing is not permitted.

- E. Placing Reinforcing:
1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
 2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
 3. Reinforcing support:
 - a. Uncoated reinforcing:
 - 1) Support reinforcing and fasten together to prevent displacement by construction operations.
 - a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
 - c) Reinforcement shown on the Contract Documents may not be repositioned for use as a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
 - 2) Reinforcing supported on ground:
 - a) Slab on grade and other members with only one mat of reinforcing:
 - (1) Provide metal bar supports with bottom plate.
 - (2) Do not use concrete blocks to support slab-on-grade reinforcing.
 - b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
 - 3) Reinforcing supported on formwork:
 - a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
 - b) All other formed surfaces:
 - (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
 - (2) Only tips in contact with the forms need to be plastic coated.
 4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
 5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 IN.
 - a. Place spacer bars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
 6. Extend reinforcement to within 2 IN of concrete perimeter edges.
 - a. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
 7. To assure proper placement, furnish templates for all column vertical bars and dowels.
 8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
 - a. Do not bend reinforcing by means of heat.
 9. Do not tack weld reinforcing.
 10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
 - a. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

- A. Reinforcement Congestion and Interferences:
 - 1. Notify Engineer whenever the specified clearances between bars cannot be met.
 - 2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
 - 3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
 - 4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
 - 5. No cutting of reinforcing shall be done without written approval of Engineer.
- B. Special Inspection:
 - 1. See Section 01 45 33.
 - 2. See Section 03 05 05.

END OF SECTION

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SECTION 03 31 30
CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete materials, strengths and proportioning for concrete work.
 - 2. Grouting:
 - a. Base plates for columns and equipment.
 - b. As specified and indicated in the Contract Document.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 05 05 - Concrete Testing and Inspection.
 - 4. Section 03 15 19 - Anchorage to Concrete.
 - 5. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - 6. Section 03 41 33 - Precast and Prestressed Concrete.
 - 7.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - c. 212.3R, Chemical Admixtures for Concrete.
 - d. 232.2R, Use of Fly Ash in Concrete.
 - 2. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.
 - b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - d. C150, Standard Specification for Portland Cement.
 - e. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
 - f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
 - h. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
 - i. C494, Standard Specification for Chemical Admixtures for Concrete.
 - j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - k. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - l. C1116, Standard Specification for Fiber-Reinforced Concrete.
 - m. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 - n. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
 - o. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.

- p. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- q. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
- 3. Steel Deck Institute (SDI):
 - a. 31, Design Manual for Composite Decks, Form Decks and Roof Decks.

1.3 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI CT-13.
- B. Water-Bearing Concrete: Any concrete surface to be in contact with process fluids during normal operation of the facility, including, but not limited to, tank, channels, wet wells and distribution chambers.
- C. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's instructions.
 - c. Concrete mix designs as required by Specification Section 03 05 05.
 - d. Manufacturer and type of proposed admixtures.
 - e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
 - 3. Certifications:
 - a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
 - b. Certification that the SCM meet the quality requirements stated in this Specification Section, and SCM supplier's certified test reports for each shipment of SCM delivered to concrete supplier.
 - c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
 - d. Certification of aggregate gradation.
 - e. Certification of coarse aggregate impurities as relates to alkali-silica reactivity per ASTM C33, Appendix X.
 - f. Certification of shrinkage test results.
 - 4. Test reports:
 - a. Cement and SCM mill reports for all cement to be supplied.
 - b. Provide test results for alkali-silica reactive impurities on coarse aggregates per referenced ASTM standards.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage of Materials:
 - 1. Store cement and SCM in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
 - 2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
 - 3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
 - 4. Do not use frozen or partially frozen aggregates.
 - 5. Do not use bottom 6 IN layer of stockpiled material in contact with ground.

6. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
 - a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
 - b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:
 1. Non-shrink grout:
 - a. BASF Corporation.
 - b. Euclid Chemical Company.
 - c. Five Star Products, Inc.
 2. Epoxy grout:
 - a. BASF Corporation.
 - b. Five Star Products, Inc.
 - c. Euclid Chemical Company.
 - d. Sika Corporation.
 3. Synthetic fibers:
 - a. GCP Applied Technologies, Inc.
 - b. BASF Corporation.
 - c. Euclid Chemical Company.

- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Cement:
 1. ASTM C150, Type II.
 2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.
- B. SCM:
 1. Fly Ash:
 - a. ASTM C618, Class F or Class C.
 - b. Non-staining.
 - c. Suited to provide hardened concrete of uniform light gray color.
 - d. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
 - e. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
 - f. Evaluate and use in accordance with ACI 232.2R.
 2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.
- C. Admixtures:
 1. Air entraining: ASTM C260.
 2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
 3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
 4. All concrete mixes require the use of water reducers to maintain the specified water-to-cement ratios without additional cement.
 5. SCM: Per above.
 6. Admixtures to be chloride free.
 - a. Do not use calcium chloride.

7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
 8. Provide admixtures certified by manufacturer to be compatible with other admixtures.
 9. Shrinkage reducing admixtures:
 - a. Admixture used to reduce the shrinkage of Portland Cement concrete.
 - b. Utilize at dosage necessary to help achieve required shrinkage value stated herein.
 - c. Similar to:
 - 1) Eclipse 4500 by GCP Applied Technologies, Inc.
 - 2) Conex by Euclid Chemical Co.
 - 3) MasterLife SRA 20 or MasterLife CRA 007 by BASF Corporation.
 - 10.
- D. Macrosynthetic Fibers:
1. Conform to ASTM C1116.
 2. Dosage to obtain a minimum average residual strength at a net deflection of L/150: 170 PSI in accordance with ASTM C1609 and ASTM C1399.
 3. Acceptable manufacturers:
 - a. MasterFiber MAC Series by BASF Corporation.
 - b. Strux 90/40 by GCP Applied Technologies, Inc.
 - c. Tuf-Strand SF by Euclid Chemical Company.
- E. Microsynthetic Fibers:
1. Conform to ASTM C1116.
 2. Minimum average residual strength at a net deflection of L/150: 170 PSI in accordance with ASTM C1609.
 3. Acceptable manufacturers:
 - a. BASF Corporation; MasterFiber F or M Series.
 - b. Fiberstrand by Euclid Chemical Company.
 - c. Gilco Fibers by GCP Applied Technologies, Inc.
- F. Water:
1. Potable.
 2. Clean and free from deleterious substances.
 3. Free of oils, acids and organic matter.
- G. Aggregates for Normal Weight Concrete:
1. ASTM C33.
 2. Fine and coarse aggregates to be regarded as separate ingredients.
 3. Provide aggregates approved for bridge construction by the Department of Transportation of the State the project is located.
 4. Coarse aggregate:
 - a. Use only washed aggregates.
 - b. Coarse aggregate sieve analysis:
 - 1) Per Table 1 IN the PART 2 MIXES Article.
 5. Fine aggregates to be natural, not manufactured.
 6. Do not use aggregates that may be deleteriously reactive when combined with alkalis in cement.
 - a. Evaluate proposed aggregates for potential deleterious expansion due to alkali silica reactivity per ASTM C33 (Appendix X), ASTM C227, ASTM C1260, ASTM 1293, or ASTM C1567.
- H. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218:
1. Prestressed concrete: 0.06.
 2. All other concrete: 0.10.
- I. Sand Cement Grout (referred to as "Grout" on the Drawings):

1. Approximately three parts sand, one part Portland cement, 6 ± 1 PCT entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
 - a. Provide sand in accordance with requirements for fine aggregate for concrete.
 2. Minimum 28 day compressive strength:
 - a. 3000 PSI.
 - b. Shall be at least strength of parent concrete when used at construction joints.
- J. Non-shrink Grout:
1. Non-shrink, nonmetallic, noncorrosive, and nonstaining.
 - a. Conform to ASTM C1107.
 2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
 3. Grout to produce a positive but controlled expansion.
 - a. Mass expansion shall not be created by gas liberation or by other means.
 4. Minimum 28 day compressive strength: 7,000 PSI.
 5. Acceptable manufacturers:
 - a. BASF Admixtures, Inc. "Masterflow, 713".
 - b. Euclid Chemical "NS Grout".
 - c. Sika Corporation "Sika Grout 212".
 - d. Sauereisen, Inc. "F-100 Level Fill Grout".
- K. Epoxy Grout:
1. Three-component epoxy resin system:
 - a. Two liquid epoxy components.
 - b. One inert aggregate filler component.
 2. Adhesive acceptable manufacturers:
 - a. BASF "Masterflow 648".
 - b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
 - c. Euclid Chemical "E3 Flowable."
 - d. Sika "Sikadur Hi-Mod."
 3. Aggregate acceptable manufacturers:
 - a. BASF "Masterflow 648".
 - b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
 - c. Euclid Chemical "Euclid aggregate."
 - d. Sika aggregate.
 4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
 5. The aggregate shall be compatible with the adhesive.
 6. Each component furnished in separate package for mixing at jobsite.
- L. See Specification Section 03 31 31 for Grout Schedule of use.

2.3 MIXES

- A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
 2. Ready-mixed concrete shall conform to ASTM C94/C94M.
 3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.
- B. Concrete Mixes: Refer to Table 1 below.
- C. Air Entrainment:
1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
 - a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.
- D. Slump:

1. Measure slump at point of discharge into concrete members.
 2. Walls and columns:
 - a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
 - b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.
 3. All other members:
 - a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
 - b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.
 4. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
 5. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
 - a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ration is not exceeded.
 6. Slump may be adjusted in the field through the use of water reducers.
 - a. Coordinate dosage and mixing requirements with concrete supplier.
 7. Slump tolerances shall comply with the requirements of ACI 117.
- E. Proportioning:
1. General:
 - a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
 - b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
 2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
 - a. Target cementitious materials contents are intended to provide a crack free, durable finished product, not one with excessive strength
 3. SCM:
 - a. Fly ash:
 - 1) For cast-in-place concrete only, a maximum of 25 PCT by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
 - 2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
 - 3) Concrete containing fly ash shall not be used in the construction of the precast concrete units specified in Specification Section 03 41 33].
 4. Water reducing, retarding, and accelerating admixtures:
 - a. Use in accordance with manufacturer's instructions.
 - b. Add to mix at batching plant.
 - c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
 - 1) Water reducers are required to maintain specified maximum water to cement ratios.
 5. High range water reducers (superplasticizers):
 - a. Use required for:
 - 1) All concrete to be pumped except slabs on grade.
 - 2) All concrete for water containing structures.
 - 3) Other concrete members at Contractor's option.
 - b. Maximum concrete slump before addition of admixture to be 3 IN maximum slump after addition to be 8 IN.

- c. Reference Specification Section 03 31 31 for additional requirements.
 - 6. Concrete mix proportioning methods for normal weight concrete:
 - a. Method 1:
 - 1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
 - 2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
 - 3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 PCT specified.
 - 4) For each water cement ratio or cement content, make at least three trial strength tests for specified test age, and cure in accordance with ASTM C192.
 - a) Cylinder size: Per ASTM C31.
 - b) Test for strength at 28 days in accordance with ASTM C39.
 - (1) Quantity of cylinders per trial strength test:
 - (a) 6 IN DIA cylinders: Two.
 - (b) 4 IN DIA cylinders: Three.
 - 5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
 - 6) From this curve select water cement ratio or cement content to be used to produce required average strength.
 - 7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
 - 8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
 - 9) See paragraph hereafter for definition of required average strength.
 - b. Method 2:
 - 1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
 - 2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
 - 3) Field test records to represent materials, proportions and conditions similar to those specified.
 - a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
 - b) Field test records shall meet the requirements of ACI 318, Paragraph 5.3.
 - 4) Required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records each of which meets the requirements of this Specification Section.
 - 7. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with ACI 318 Chapter 5 using the standard deviation of the proposed concrete production facility as described in ACI 318, Chapter 5.
- F. Controlled Low-Strength Material (CLSM):
 - 1. A mixture of cement, fly ash, fine sand, water and air having a consistency which will flow under a very low head.
 - 2. Approximate quantities of each component per cubic yard of mixed material:
 - a. Cement (Type I or II): 50 LBS.
 - b. Fly ash: 200 LBS.
 - c. Fine sand: 2,700 LBS.
 - d. Water (approximate): 420 LBS.
 - e. Air content (approximate): 10 PCT.
 - 3. Actual quantities shall be adjusted to provide a yield of 1 CUYD with the materials used.
 - 4. Approximate compressive strength should be 85 to 175 PSI.

5. Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.

G. Allowable Shrinkage:

1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.
2. Continue testing to 64 weeks for informational purposes.

TABLE 1							
TYPE OF CONCRETE	28 DAY COMPRESSIVE STRENGTH	W/C RATIO	TARGET TOTAL CEMENT	SCM	ASTM C33 Size No.	AIR CONTENT	ALLOWABLE SHRINKAGE LIMIT
Normal weight lean concrete	3000 PSI	0.45	517	Note 1	7	[5-1/2 to 8] [0 to 2]	[None]
Normal weight concrete fill [utility encasement concrete]	3000 PSI	0.45	517	Note 1	57	[4-1/2 to 7-1/2]	[None]
Normal weight concrete topping	4000 PSI	0.45	564	Note 1	7	[5-1/2 to 8]	[None]
Normal weight precast concrete	5000 PSI	0.42	611		57	[4-1/2 to 7-1/2]	[None]
Normal weight concrete w/ power trowel finish	4000 PSI	0.45	564	Note 1	[57] [67]	[0 to 2]	[0.048] PCT
Normal weight water-bearing concrete	4500 PSI	0.42	564	Note 1	[57] [67]	[4-1/2 to 7-1/2]	[0.042][0.032] PCT
Drilled pier concrete	[4000 PSI] [4500 PSI]	[0.45] [0.42]	564	Note 1	[57]	[4-1/2 to 7-1/2]	None
Normal weight all other concrete	[4000 PSI]	0.45	564	Note 1	[57] [67]	[4-1/2 to 7-1/2]	[0.048] PCT

Table 1 Notes:

1. If fly ash [or GGBFS] is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.

2.4 SOURCE QUALITY CONTROL

- A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanliness and grading on samples secured from aggregates at point of batching.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Special Inspection:
 1. See Specification Section 01 45 23.
 2. See Specification Section 03 05 05.
- B. Perform concrete tests per Specification Section 03 05 05.
 1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
 - a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

SECTION 03 31 31
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mixing, placing, jointing, and curing of concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 01 45 23 – Special Inspections and Testing Program.
 - 4. Section 03 05 05 - Concrete Testing and Inspection.
 - 5. Section 03 11 13 - Formwork.
 - 6. Section 03 21 00 - Reinforcement.
 - 7. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 8. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
 - 9. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. 304.2R, Placing Concrete by Pumping Methods.
 - e. 305R, Guide to Hot Weather Concreting.
 - f. 305.1, Specification for Hot Weather Concreting.
 - g. 306R, Guide to Cold Weather Concreting.
 - h. 306.1, Standard Specification for Cold Weather Concreting.
 - i. 308.1, Specification for Curing Concrete.
 - j. 309R, Guide for Consolidation of Concrete.
 - k. 318, Building Code Requirements for Structural Concrete and Commentary.
 - l. 360R, Guide to Design of Slabs-on-Ground.
 - 2. ASTM International (ASTM):
 - a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 3. Corps of Engineers (COE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstop.
 - 4. National Ready Mixed Concrete Association (NRMCA):
 - a. Checklist for Certification of Ready Mixed Concrete Production Facilities.

- B. Qualifications:
1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.
 2. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost to Owner.
- C. Pre-Concreting Conference:
1. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 30 days after the Notice to Proceed.
 - a. Schedule the meeting to occur no later than five days in advance of the first scheduled date of concrete placement.
 2. All parties involved in the concrete work shall attend the conference, including:
 - a. Contractor's representative.
 - b. Testing laboratory representative/inspectors.
 - c. Concrete subcontractor.
 - d. Reinforcing steel installer.
 - e. Concrete supplier.
 - f. Owner.
 - g. Resident Engineer or Project Representative.
 - h. Design Engineer.
 - i. Building Code Official.
 3. The conference shall be held at a mutually agreed upon time and location.
 4. The agenda shall include but not be limited to the following:
 - a. Scheduling, sequence and notification of concrete placements.
 - b. Contractor's concrete pre-placement plan checklist.
 - c. Delivery time from batch plant, maximum time in truck, and approved exceptions to the limits.
 - d. Review of approved design mix including the limits of water that can be added and who is authorized to add water, if water has been withheld at the plant.
 5. Additional test cylinders for structural elements the Contractor intends to subject to live loads earlier than 28 days.
 6. Duties and authority of testing and inspection agency.
 7. Curing procedures.
 8. Temperature/weather issues.
 9. Test cylinder storage and protection.
 10. Approval and rejection of work.
 11. Mock-up panels as the standard.

1.3 DEFINITIONS

- A. Words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 1) Procedure for adding high-range water reducer at the jobsite.
 - c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.

- d. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Construction joint bonding adhesive.
 - 4) Waterstops.
- 3. Certifications:
 - a. Ready mix concrete plant certification.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Copies of concrete delivery tickets.
 - 3. Description of proposed curing methods.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Concrete Delivery:
 - 1. Prepare a delivery ticket for each load of ready mixed concrete.
 - 2. Truck operator shall hand ticket to Contractor at the time of delivery.
 - 3. Ticket to show:
 - a. Mix identification.
 - b. Quantity delivered.
 - c. Amount of material in each batch.
 - d. Outdoor temperature in the shade.
 - e. Time at which cement was added.
 - f. Time of delivery.
 - g. Time of discharge.
 - h. Amount of water that may be added at the site without exceeding the specified water-cement ratio.
 - i. Amount of any approved water added at the site.

1.6 PROJECT CONDITIONS

- A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
 - 1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.7 SEQUENCING AND SCHEDULING

- A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
 - 1. Approval of concrete mix design does not relieve Contractor of his responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.
- B. Neoprene Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. Permaglaze.
 - b. Rubatex.
 - c. Williams Products.
 - 2. Materials:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Type 2, Class A or C.

- c. Grade: Compression deflection as required to limit deflection to 25 PCT of joint thickness under pressure from concrete pour height.
- C. Asphalt Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. W.R Meadows.
 - b. J and P Petroleum Products.
 - 2. Materials: ASTM D994.
- D. Fiber Expansion Joint Fillers:
 - 1. Materials: ASTM D1751.
- E. Waterstops, PVC Type:
 - 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastic Products.
 - b. W.R Meadows.
 - c. Vinylex Corporation.
 - d. Bometals, Inc.
 - 2. Materials:
 - a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
 - b. Cast-in-place type: COE CRD-572.
 - 3. Approved profiles as listed.
 - a. Construction joints:
 - 1) Ribbed: 6 IN wide by 3/8 IN.
 - 2) Sika Greenstreak Plastic Products Style #679, or equal.
 - b. Control joints:
 - 1) 6 IN wide by 3/8 IN thick with ribs and center bulb.
 - 2) Sika Greenstreak Plastic Products Style #705, or equal.
 - c. Expansion joint:
 - 1) 9 IN wide by 3/8 IN thick center bulb 2 inch OD.
 - 2) Sika Greenstreak Plastic Products Style #739, or equal.
 - 4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum 6 IN clear of the intersection.
 - 5. Factory prepunched (less than 18 IN centers, each edge, staggered) for wire supports.
 - a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
 - 6. See Drawings for application and other requirements.
- F. Waterstops, Preformed Strip Type:
 - 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastics, Inc. (Hydrotite).
 - b. Adeka Ultra Seal USA (MC-2010MN).
 - c. DeNeef (Swellseal 2010).
 - 2. Hydrophilic, non-bentonite composition.
 - 3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
 - 4. Volumetric expansion limited to 3 times maximum.
 - 5. See Drawings for application and other requirements.
- G. Water Swelling Sealant:
 - 1. Required adhesive for use with strip-type waterstop.
 - 2. Compatible with strip-type waterstop.
 - 3. Single component, gun applied.
 - 4. Moisture cured.
 - 5. Minimum 70 PCT volumetric expansion swelling capability.

- H. Curing Products to conform to one or more of the following:
1. Absorbent Covers.
 2. Moisture Retaining Covers.
 - a. Moisture Retaining Fabric.
 3. Dissipating curing compound:
 - a. Fugitive dye, waterborne, membrane-forming.
 - b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition and performance of applied finishes.
 - c. Acceptable Products:
 - 1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
 - 2) Euclid Chemical Company (The); Kurez DR VOX.
 - 3) L&M Construction Chemicals, Inc.; L&M Cure R.
 4. Clear, watersolvent-borne, membrane-forming curing and sealing compound:
 - a. ASTM C1315, Type 1, Class A.
 - b. Moisture loss shall be not more than 0.40 KG/M² when applied at 300 SQFT/GAL.
 - c. Manufacturer's certification is required.
 - d. Subject to project requirements, provide one of the following products:
 - e. Products:
 - 1) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
 - 2) L&M Construction Chemicals, Inc.; Lumiseal Plus.
 - 3) Meadows, W.R., Inc.; CS-309/30.
 - 4) Euclid Chemical Company; Super Diamond Clear VOX.
 - 5) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - 6) Meadows, W.R., Inc.; Vocomp-30.
- I. Vapor Retarder: See Specification Section 07 26 00.
- J. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03 31 30 for this non-structural material and use.

2.2 SOURCE QUALITY CONTROL

- A. The concrete plant shall conform to the Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.

PART 3 - EXECUTION

3.1 PREPARATION

- A. General:
1. All materials and construction shall conform to the tolerances as specified in ACI 117.
 2. Complete formwork.
 - a. See Specification Section 03 11 13.
 3. Remove earth, snow, ice, water, and other extraneous/foreign materials from areas that will receive concrete.
 4. Secure reinforcement in place.
 - a. See Specification Section 03 21 00.
 5. Position expansion joint material, anchors and other embedded items.
 6. Obtain approval of formwork, reinforcement installation and placement prior to placing concrete.

7. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and prior Engineer approval is obtained.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
 - b. Do not allow rainwater to increase mixing water nor to damage surface finish.
 8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
 9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
 - a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.
- B. Preparation of Subgrade for Slabs On Ground:
1. Subgrade to be wetted without standing water immediately prior to placing concrete.
 2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
- C. Edge Forms and Screeds:
1. Set accurately to produce designated elevations and contours of finished surface.
 2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
 3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

- A. General:
1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
 2. Batch, mix, and transport in accordance with ASTM C94/C94M.
- B. Control of Admixtures:
1. Control at the batch plant:
 - a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.
 - b. Charge admixtures into mixer as solutions.
 - 1) Measure by means of an approved mechanical dispensing device.
 - 2) Liquid considered a part of mixing water.
 - 3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
 - c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
 - d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.
 2. Control of Admixtures in the field:
 - a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
 - 1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
 - 2) Addition of each admixture to be documented on the delivery ticket.
 - 3) Provide additional mixing per ASTM C94.
- C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
 2. Discard concrete which has set.
 3. Discharge concrete from ready mix trucks within time limit stated in ASTM C94.
 4. Addition of water at the jobsite:

- a. See Specification Section 03 31 30 for specified water cement ratio and slump.
- b. Do not exceed maximum specified water cement ratio or slump.
- c. Incorporate water by additional mixing equal to at least half of total mixing required.

3.3 PLACING OF CONCRETE

A. General:

1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
 - a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
2. Comply with ACI 304R and ACI 304.2R.
3. Do not begin placing concrete during rain, sleet, or snow.
 - a. Protect fresh concrete from ensuing inclement weather.
4. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
5. Begin work only when work of other trades affecting concrete is complete.
6. Do not use excess grout or mortar to lubricate lines when pumping concrete.
7. Do not use excess water for workability or any reason when placing concrete by freefall.
8. Deposit concrete continuously to avoid cold joints.
9. Locate construction joints at locations specified or approved by Engineer.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
10. Spreaders:
 - a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
 - b. Embedded:
 - 1) Obtain approval of Engineer for their use.
 - 2) Materials: Concrete or metal.
 - 3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
11. Deposit concrete as nearly as practicable in its final position to avoid segregation.
 - a. Maximum free fall: 4 FT.
 - b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface.
12. Perform the following operations before bleeding water has an opportunity to collect on surface:
 - a. Spread.
 - b. Consolidate.
 - c. Straightedge.
 - d. Darby or bull float.
13. No water shall be added to the concrete surface to ease finishing operation.
14. Do not discharge water into forms.
15. Consider use of form vibrators for certain placement situations.

B. Cold Weather Concrete Placement:

1. Comply with ACI 306.1.
2. Do not place concrete on forms or subgrades that are below 32 DEGF or contain frozen material.
3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
4. Temperature of concrete when discharged at site: Per ACI 306.1.
5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DEGF, when temperature of surrounding air is 40 DEGF or below at time concrete is placed.
 - a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DEGF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DEGF.

8. Follow ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.
- C. Hot Weather Concrete Placement:
1. Comply with ACI 305.1.
 2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
 3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
 - a. Not to exceed 90 DEGF.
 - b. Not so high as to cause:
 - 1) Shrinkage cracks.
 - 2) Difficulty in placement due to loss of slump.
 - 3) Flash set.
 4. Temperature of forms and reinforcing when placing concrete:
 - a. Not to exceed 90 DEGF.
 - b. May be reduced by spraying with water to cool below 90 DEGF.
 - 1) Leave no standing water to contact concrete being placed.
 5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.
- D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
 2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
 - a. Ensure no displacement of reinforcing or other embeds from final position.
 - b. Eliminate:
 - 1) Air or stone pockets.
 - 2) Honeycombing or pitting.
 - 3) Planes of weakness.
 3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
 - a. Size and coordinate external vibrators to specifically match forming system used.
 4. Internal vibrators:
 - a. Minimum frequency of 8000 vibrations per minute.
 - b. Insert and withdraw at points approximately 18 IN apart.
 - 1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
 - c. Use in:
 - 1) Beams and girders of framed slabs.
 - 2) Columns and walls.
 - 3) Vibrating concrete around all waterstops.
 - d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
 5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
 6. Do not use vibrators to transport concrete within forms.
 7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the work.
 8. Provide sufficient spare vibrators on jobsite during all concrete placing operations to assure continuous vibration.
 9. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
 10. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

- E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
 - 1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
 - 2. Horizontal belt conveyors:
 - a. Mount at a slope which will not cause segregation or loss of ingredients.
 - b. Protect concrete against undue drying or rise in temperature.
 - c. Use an arrangement at discharge end to prevent segregation.
 - d. Do not allow mortar to adhere to return length of belt.
 - e. Discharge conveyor runs into equipment specially designed for spreading concrete.
 - 3. Metal or metal lined chutes:
 - a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
 - b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
 - c. Provide end of each chute with a device to prevent segregation.
 - 4. Pumping or pneumatic conveying equipment:
 - a. Designed for concrete application and having adequate pumping capacity.
 - b. Control pneumatic placement so segregation is avoided in discharged concrete.
 - c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
 - d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
 - e. Provide pumping equipment without Y sections.
- F. Placing of Concrete on Metal Deck:
 - 1. Prior to concrete placement, the metal deck shall be free of soil, debris, standing water, loose mill scale, and all other foreign matter.
 - 2. Care shall be exercised when placing concrete so that the deck will not be subject to construction loads or impact that exceed the design capacity of the deck.
 - 3. Concrete shall be placed in a uniform manner and spread toward the center of the deck span.
 - 4. If buggies are used to place concrete, runways shall be planked, and the buggies shall only operate on planking.
 - a. Planks shall be of adequate stiffness to transfer loads to the steel supports without damaging the deck.
 - 5. Deck damage caused by careless placement of concrete shall be repaired or replaced.
 - 6. Pour concrete to the thickness and elevations noted on Drawings.

3.4 JOINTS AND EMBEDDED ITEMS

- A. Construction Joints - General:
 - 1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
 - a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Specification Section.
 - 2. Unplanned construction joints will not be allowed.
 - a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
 - 3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
 - 4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
 - a. At Contractor's option, beam pockets may be formed into concrete walls.
 - b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
 - 5. Place beams, girders, column capitals and drop panels at same time as slabs.

6. Place corbels monolithically with their supporting members.
 - a. Locate wall vertical construction joints midway between corbels.
 - b. Where only a single corbel is located, place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
 7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
 8. Provide the following joints unless noted otherwise on Drawings:
 - a. Roughen joints: horizontal construction joints.
 - b. Keyed joints: vertical construction joints.
 9. Roughen construction joints:
 - a. Clean the previously hardened concrete interface and remove all laitance.
 - b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
 10. Keyways:
 - a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or as directed by Engineer.
 - b. Wall keys:
 - 1) Keyway width, not less than 1/3 and not more than 1/2 the wall thickness measured perpendicular to wall faces.
 - 2) Keyway depth to be not less than 1-1/2 IN.
 - 3) Continuous along length of wall.
 - 4) Place keyway in wall center unless shown otherwise on Drawings.
 - c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
 - 1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
 - 2) Keyway depth not less than 1-1/2 IN.
 - 3) Continuous along footing or slab.
 - 4) Keyway in footing or slab center unless shown otherwise on Drawings.
 - d. Beam keyways:
 - 1) Full width of beam.
 - 2) Keyway height not less than 5-1/2 IN.
 - 3) Keyway depth not less than 1-1/2 IN.
 - 4) Keyway located in initial beam pour, directly above the bottom reinforcing, unless shown otherwise on Drawings.
 11. Minimum time before placement of adjoining concrete construction:
 - a. All concrete: 60 HRS, unless otherwise noted.
- B. Construction Joints - Spacing Unless Otherwise Specified:
1. Structures not intended to contain liquid:
 - a. Wall vertical construction joints:
 - 1) 50 FT maximum centers.
 - 2) At wall intersections, 4 FT minimum from corner.
 - b. Base slab, floor, and roof slab construction joints:
 - 1) Placements to be approximately square and not to exceed 40 00 SQFT.
 - 2) Maximum side dimension of a slab pour to be 70FT.
 2. Water retaining structures:
 - a. Wall vertical construction joints:
 - 1) 30 FT maximum centers.
 - 2) At wall intersections, 6 FT minimum from corner.
 - b. Wall horizontal construction joints: 22 FT centers.
 - c. Floor slab, construction joints:
 - 1) Placements to be approximately square and not to exceed 2000 SQFT.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 60 FT.
 - d. Elevated slab construction joints:
 - 1) Placements to be approximately square and not to exceed 4000 SQFT.

- 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 70 FT.
- C. Construction Joints - Bonding:
1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
 2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as outlined below:
 3. Roughen construction joints:
 - a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 1/4 IN minimum amplitude.
 - 1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
 4. Keyed construction joints:
 - a. Thoroughly clean construction joints and remove all laitance.
 - b. Dampen the hardened concrete immediately prior to placing of fresh concrete.
- D. Slab On Grade Joints:
1. Locate construction and control joints in slabs on grade as indicated on Drawings.
 2. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
 - a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
 - b. Complete before shrinkage stresses become sufficient to produce cracking.
- E. Expansion Joints:
1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
 2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
 3. Seal expansion joints as shown on Drawings.
 - a. See Specification Section 07 92 00 for requirements.
- F. Waterstops - General:
1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
 2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
 3. Preformed strip type:
 - a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
 - 1) Maintain at least 3 IN from edge of concrete or as recommended by manufacturer.
 - b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
 - c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
 - d. Use in joints against existing concrete where indicated on Drawings.
 4. PVC waterstops:
 - a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
 - b. Secure waterstops in correct position using hog rings or grommets spaced no more than 18 IN maximum staggered along each edge full length and passed through the edge of the waterstop.
 - 1) Tie wire to adjacent reinforcing.
 - c. Hold horizontal waterstops in place with continuous supports.
 - d. Install according to manufacturer's instructions.
 - 1) Do not displace reinforcement from required location.

- e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
 - 1) Use factory fabricated "T" and corner intersection fittings.
 - 2) Field splice straight runs of material.
 - f. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.
- G. Other Embedded Items:
- 1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
 - a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.
 - 2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.
- H. Placing Embedded Items:
- 1. Support against displacement.
 - 2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
 - 3. Provide adequate means for anchoring waterstop in concrete.
 - a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.5 FINISHING

- A. See Specification Section 03 35 00.
- B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

- A. Grout Schedule:
 - 1. Sand cement grout:
 - a. Fill keyways in precast HCU.
 - b. Construction joint bedding (base of wall pours with comparable compressive strength to wall).
 - c. General use.
 - d. As noted on Drawings.
 - 2. Non-shrinking non-metallic grout:
 - a. Filling form tie holes.
 - b. Under column and beam base plates.
 - c. Other uses indicated on the Drawings.
 - 3. Epoxy grout:
 - a. Patching cavities in concrete.
 - b. Grouting of dowels and anchor bolts into existing concrete.
 - c. Grouting of rotating or oscillating equipment base plates where driving motor is 500 HP and above.
 - d. As noted on the Drawings.
- B. Grout Installation:
 - 1. Sand cement grout:
 - a. Fill wetted keyways between precast concrete hollow core slabs with sand cement grout.
 - b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
 - c. Cure grout by one of methods specified.
 - 2. Non-shrink non-metallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 HRS prior to grouting.
 - c. Mix in a mechanical mixer.

- d. Use no more water than necessary to produce flowable grout.
 - e. Place in accordance with manufacturer's instructions.
 - f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast slabs, and in other locations indicated on the Drawings.
 - g. Completely fill all spaces and cavities below the top of base plates.
 - h. Provide forms where base plates and bed plates do not confine grout.
 - i. Where exposed to view, finish grout edges smooth.
 - j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
 - k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
3. Epoxy grout:
- a. Mix and place in accordance with manufacturer's instructions.
 - b. Apply only to clean, dry, sound surface.
 - c. Completely fill all cavities and spaces around dowels and anchors without voids.
 - d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
 - e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
- 1. Follow recommendations of ACI 308.1 except as modified herein.
 - 2. Do not impose loads by foot traffic, wheeled traffic, and other loads until concrete has sufficiently cured to carry imposed loads without adversely affecting the concrete. In no event shall concrete be subject to loading or traffic during initial 48 HRS of curing, unless otherwise approved by Engineer.
- B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
- 1. Ponding or continuous sprinkling. Take care to avoid eroding the surface of freshly placed concrete.
 - 2. Application of wet Absorbent Covers:
 - a. Minimum lap: 12 IN.
 - b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as required to keep concrete surface continuously wet.
 - c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
 - 3. Continuous application of steam (not exceeding 150 DEGF) or mist spray.
 - 4. Application of Moisture Retaining Cover sheet materials.
 - a. Place as soon as possible after final finishing and without marring the surface.
 - b. Minimum lap: 12 IN.
 - c. Seal all edges to make water-tight.
 - d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
 - e. Hold cover and edges in place as required to prevent wind from displacing the cover.
 - f. Moisture Retaining Fabric:
 - 1) Install in accordance with manufacturer's written recommendations.
 - 2) Saturate concrete surface and fabric side of cover immediately prior to placing.
 - g. Monitor continuously during the curing period:
 - 1) Repair any holes, tears or displaced cover.
 - 2) Rewet as required to keep concrete moist under cover.
 - 5. Application of other moisture retaining covering as approved by Engineer.
 - 6. Water used for curing shall be within 20 DEGF of the concrete temperature.

7. Application of a curing compound.
 - a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
 - b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
 - c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
 - 1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
 - 2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - 3) Allow the preceding coat to completely dry prior to applying the next coat.
 - 4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
 8. Surfaces In Contact with Forms:
 - a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
 - 1) See Section 03 11 13.
 - b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
 - c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
 - d. After form removal, cure concrete until end of time prescribed.
 - e. Use one of the methods listed above.
 - f. Forms left in place shall not be used as a method of curing in hot weather.
 - g. The term "hot weather", where used in these specifications, is defined in ACI 305.1.
 - h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.
- C. Curing Period:
1. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
 - a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.
- D. Cold Weather:
1. Follow recommendations of ACI 306.1.
 2. Maintain temperature of concrete per ACI 306.1 for a minimum of 72 HRs after concrete is placed, when outdoor temperature is 40 DEGF, or less.
 - a. Maximum temperature rate of decrease: Per ACI 306.1.
 3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
 4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.
- E. Hot Weather:
1. Follow recommendations of ACI 305.1 and ACI 308.1.
 2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
 3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
 4. Maximum temperature rate of decrease: Per ACI 305.1.

- F. Rate of Temperature Change:
 - 1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
- G. Protection from Mechanical Injury:
 - 1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
 - 2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
 - 3. Do not load self-supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

- A. Special Inspections per building code:
 - 1. See Section 01 45 23 and 03 05 05.

END OF SECTION

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SECTION 03 35 00
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete finishing and repair of surface defects.
 - 2. Chemical Sealers.
 - 3. Polymer Modified Cementitious Coating.
 - 4. Resurfacing Mortar.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 11 13 - Formwork.
 - 4. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
 - d. 308, Standard Practice for Curing Concrete.
 - 2. ASTM International (ASTM):
 - a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
 - b. C150, Standard Specification for Portland Cement.
 - c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - i. D4259, Standard Practice for Abrading Concrete.
 - j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
 - k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
 - 3. International Concrete Repair Institute (ICRI):
 - a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 - 4. National Council Highway Research Program (NCHRP):
 - a. 244, Concrete Sealers for the Protection of Bridge Structures.
 - 5. The Society for Protective Coatings/NACE International (SSPC/NACE):
 - a. SP 13/NACE No. 6, Surface Preparation of Concrete.

- B. Qualifications:
 - 1. Chemical Sealer CS-2:
 - a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
 - b. Applicator shall have a minimum of five years of experience successfully applying materials specified.
- C. Mock-Ups.
 - 1. General:
 - a. Construct additional mock-ups as required until accepted.
 - b. Mock-ups constitute minimum standard of quality for actual construction.
 - c. Maintain mock-up during construction.
 - d. Remove when directed by Engineer.
 - 2. Construct mock-up for each type of wall finish specified for review and acceptance by Engineer.
 - a. Minimum 4 x 4 FT area for each different wall finish specified.
 - b. Mock-ups shall include:
 - 1) Sample of patched tie hole.
 - 2) Sample of all jointery being used in the walls.
 - c. Include mock-up of wall having polymer modified cementitious coating.
 - 1) Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
 - 3. Construct mock-up floor slab for review and acceptance by Engineer.
 - a. Minimum 10 x 10 FT.

1.3 DEFINITIONS

- A. Vertical Surface Defects:
 - 1. Any void in the face of the concrete deeper than 1/8 IN, such as:
 - a. Tie holes.
 - b. Air pockets (bug holes).
 - c. Honeycombs.
 - d. Rock holes.
 - 2. Scabbing:
 - a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
 - 3. Foreign material embedded in face of concrete.
 - 4. Fins 1/16 IN or more in height.
- B. Installer or Applicator:
 - 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 - 2. Installer and applicator are synonymous.
- C. Other words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Certifications:
 - a. Certification of aggregate gradation.
 - b. Certification of manufacturer experience qualifications and performance history.

- c. Certification of applicator's qualifications.
 - 1) Refer to Qualifications paragraph.
 - 2) Provide manufacturer's written approval of applicators.
 - 3) Provide references substantiating specialty experience.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Bonding Agents:
 - a. BASF Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - 2. Chemical Sealers:
 - a. BASF Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - d. Tnemec Chemprobe.
 - 3. Polymer Modified Cementitious Coating:
 - a. Aquafin International.
 - b. BASF Master Builders Solutions.
 - c. Euclid Chemical Co.
 - 4. Patching Mortar:
 - a. BASF Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - d. Sika Corporation.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Chemical Sealer CS-1:
 - 1. High solids, water-based solution containing acrylic copolymers.
 - a. ASTM C1315, Type I, Class A.
 - b. Non-yellowing UV resistant.
 - c. VOC Content: <200 G/L.
 - 2. USDA approved as a concrete floor sealer.
 - 3. Euclid Chemical Super Diamond Clear VOX.
- B. Chemical Sealer CS-2:
 - 1. Water based chemical solution containing a blend of silicate and silicate polymers designed to seal, harden and dustproof concrete floors.
 - 2. VOC Content: 0 G/L.
 - 3. Performance of treated concrete floor:
 - a. Coefficient of Friction:
 - 1) Dry: 0.81.
 - 2) Wet: 0.72.

- b. Liquid repellency, RILEM Method 11.4:
 - 1) ≥ 1 mL.
 - 4. Euclid Chemical Euco Diamond Hard.
- C. Chemical Sealer CS-3:
 - 1. Clear, penetrating, breathable, waterborne silane-siloxane solution.
 - 2. VOC content: ≤ 50 G/L.
 - 3. Odorless.
 - 4. Flash point: >200 DEGF.
 - 5. Water absorption: 85 PCT reduction per NCHRP 244.
 - 6. Chloride penetration: 82 PCT reduction per NCHRP 244.
 - 7. Euclid Chemical Baracade WB 244.
- D. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.
 - 1. Portland cement-based, rapid set repair mortar for interior or exterior use.
 - 2. Compressive Strength, ASTM C109:
 - a. Minimum 3000 PSI at 7 days.
 - b. Minimum 5000 PSI at 28 days.
 - 3. Freeze Thaw Durability, ASTM C666: 96.75 PCT at 300 Cycles.
 - 4. Shrinkage, ASTM C157: 0.069 PCT.
 - 5. Euclid Chemical Speed Crete Red Line.
- E. Bonding Agents:
 - 1. For use only on concrete surfaces not receiving liquid water repellent coating:
 - a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
 - 1) BASF Master Builders MasterEmaco A 660.
 - 2) Euclid Chemical Co. Flex-Con.
 - 3) Laticrete L&M Everbond.
 - 2. For use only on concrete surface receiving liquid water repellent:
 - a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
- F. Cement:
 - 1. ASTM C150, Type II Portland for areas exposed to sewage.
 - 2. ASTM C150, Type II Portland elsewhere.
- G. Aggregate:
 - 1. Sand: Maximum size #30 mesh sieve.
 - 2. For exposed aggregate finish surfaces: Same as surrounding wall.
- H. Water: Potable.
- I. Polymer modified cementitious coating:
 - 1. Polymer modified Portland cement based coating for concrete and masonry.
 - a. Waterproof.
 - b. Resistant to both positive and negative hydrostatic pressure.
 - c. Breathable.
 - 2. BASF MasterSeal 581 or Euclid Chemical Tamoseal.
 - a. Color:
 - 1) Interior surfaces: Standard gray.
 - 2) Exterior surfaces: Standard gray.
 - b. Texture: Fine.
- J. Nonshrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

2.3 MIXES

- A. Bonding Grout: One part cement to one part aggregate.

- B. Patching Mortar:
 - 1. One part cement to 2-1/2 parts aggregate by damp loose volume.
 - a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

- A. For methods of curing, see Specification Section 03 31 31.
- B. Surface Preparation:
 - 1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
 - 2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
 - a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
 - 1) Areas to receive Repair Mortar:
 - a) Areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
 - b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c. No feathered edges will be permitted.
 - d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.
- C. Preparation of Bonding Grout Mixture:
 - 1. Mix cement and aggregate.
 - 2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
 - 3. Add bonding agent/water mixture to cement/aggregate mixture.
 - 4. Mix to consistency of thick cream.
 - 5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.
- D. Preparation of Patching Mortar Mixture:
 - 1. Mix specified patching mortar per manufacturer's published recommendations.
 - 2. For repairs exceeding 2 IN in depth, mix with clean, pre-dampened 3/8 IN pea gravel in accordance with the manufacturer's recommendations.
- E. Polymer modified cementitious coating:
 - 1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

- A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DEGF.
 - 1. If necessary, enclose and heat area to between 50 and 70 DEGF during repair of surface defects and curing of patching material.
 - a. Use only clean fuel, indirect fired heating apparatus.
 - b. Exhaust combustion byproducts outside of work area.
- B. Chemical Sealer Application:
 - 1. General:
 - a. Immediately prior to Substantial Completion, thoroughly clean floor in accordance with ASTM D4258 and prepare to receive chemical sealer.
 - 1) Remove previously applied membrane curing compounds.

- 2) Remove soil, oils, stains, discoloration, or any other imperfection having a negative impact on the appearance of the finished floor.
 - b. Apply product to floor areas indicated on the Drawings.
 - c. Apply in accordance with manufacturer's published installation instructions.
 - 2. Chemical Sealer (CS-1):
 - a. Apply two uniform coats at rate recommended by manufacturer.
 - 1) Apply using manufacturer's recommended equipment with a fan-tip nozzle.
 - 2) Do not allow material to puddle.
 - b. Allow first coat to completely dry before applying second coat.
 - c. Spotted or mottled appearances will not be accepted.
 - 3. Chemical Sealer (CS-2):
 - a. Apply two uniform coats at rate recommended by manufacturer.
 - 1) Scrub the material into the floor using a mechanical scrubber.
 - a) Keep the surface wet for not less than 30 minutes.
 - b) Continue scrubbing in accordance with manufacturer's application instructions.
 - c) After material has thickened, but not more than 60 minutes after application, remove all excess liquid.
 - 2) Thoroughly rinse with clean water to remove all residue.
 - a) Damp mop with clean water to remove any streaks.
 - b) Do not allow residue to dry on floor surface.
 - 3) Do not track material onto untreated surfaces.
 - b. After rinsing, allow floor to dry completely and apply second coat following the same procedures.
 - c. Final floor finish shall have uniform sheen without streaking, stains or white residue.
 - 4. Chemical Sealer (CS-3):
 - a. Apply uniform coats at rate recommended by manufacturer.
 - 1) Apply with fine, uniform spray or microfiber pad.
 - b. Allow floor to dry completely and remove any dried residue using hot water and mild citric acid.
 - c. Final floor finish shall be uniform, free of residue, and shall repel water.
 - d. Apply additional coat(s) as necessary to achieve water repellent finish.
- C. Repairing Surface Defects:
- 1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
 - a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
 - 1) Fluid Applied Waterproofing: See Specification Section 07 14 00.
 - 2) High Performance Industrial Coatings: See Specification Section 09 96 00.
 - 2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
 - a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
 - b. Scrub bond coat:
 - 1) Wet substrate to a saturated surface dry (SSD) condition.
 - 2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire area.
 - c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
 - d. Patching Mortar Application:
 - 1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
 - 2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.

3. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
 4. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
 - a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
 5. Cure patching mortar in accordance with ACI 308.
- D. Concrete Finishes for Vertical Wall Surfaces:
1. General:
 - a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
 - b. Finish numbers not listed are "Not Used".
 2. Finish #1 - As cast rough form finish:
 - a. Selected forming materials are not required.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - c. Repair the following surface defects using patching mortar specified in PART 2:
 - 1) Tie holes.
 - 2) Honeycombs deeper than 1/4 IN.
 - 3) Air pockets deeper than 1/4 IN.
 - 4) Rock holes deeper than 1/4 IN.
 - d. Chip or rub off fins exceeding 1/4 IN in height.
 - e. Provide at unexposed surfaces such as:
 - 1) Foundations.
 - 2) Below-grade walls not to be waterproofed.
 - 3) Concealed surface of concrete back-up wythe in cavity wall construction.
 3. Finish #2 - As cast form finish:
 - a. Form facing material shall produce a smooth, hard, uniform texture.
 - 1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - 1) Chip or rub off fins exceeding 1/8 IN in height.
 - 2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
 - a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
 - (1) For contiguous repair areas larger than 1 SF or deeper than 1/4 IN
Abrasive blast, scarify or needle scale to CSP No. 6-8.
 - b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c) No feather edges will be permitted.
 - 3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
 - 4) Repair the following surface defects using patching mortar specified in PART 2:
 - a) Tie holes.
 - b) Honeycombs deeper than 1/4 IN or larger than 1/4 IN DIA.
 - c) Air pockets deeper than 1/4 IN or larger than 1/4 IN DIA.
 - d) Rock holes deeper than 1/4 IN or larger than 1/4 IN DIA.
 - e) Scabbing.
 - 5) Brush blast repaired areas to match adjacent surface texture.
 - c. Provide this finish for:
 - 1) Interior walls of , pump rooms.
 - 2) Underside of horizontal elements adjacent to the finished surface.
 - 3) Exposed surfaces not specified to receive another finish.
 4. Finish #3 - Grout rubbed finish:

- a. Provide this finish for:
5. Finish #4 - Polymer modified cementitious coating:
 - a. Form facing material shall produce a smooth, hard, uniform texture.
 - 1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
 - 2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - 1) Chip or rub off fins exceeding 1/8 IN in height.
 - 2) Abrasive blast and repair surface defects in accordance with Concrete Finish #2.
 - c. Apply decorative coating to entire surface.
 - 1) As a mixing liquid for the coating, use bonding agent and water mixture as recommended by coating manufacturer.
 - 2) Apply two (2) coats at 2 LBS per square yard per coat.
 - a) During application of first coat, complete fill all voids, depressions or other surface imperfections.
 - d. When second coat is set, float to a uniform texture with a sponge float.
 - e. Provide this finish on all exposed to view:
 - 1) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
 - 2) Underside of horizontal elements adjacent to the finished surface.
 - f. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.
- E. Related Unformed Surfaces (Except Slabs):
 1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
 2. Float surface to a texture consistent with that of formed surfaces.
 - a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
 3. Continue treatment uniformly across unformed surfaces.
- F. Concrete Finishes for Horizontal Slab Surfaces:
 1. General:
 - a. Tamp concrete to force coarse aggregate down from surface.
 - b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
 - c. Dusting of surface with dry cement or sand during finishing processes not permitted.
 2. Unspecified slab finish:
 - a. When type of finish is not indicated, use following finishes as applicable:
 - 1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 - 2) Surfaces intended to receive roofing or waterproofing membranes: Floated finish.
 - 3) Floors : Troweled finish.
 - 4) Garage floors and ramps: Broom or belt finish.
 - 5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
 - 6) All slabs to receive a floated finish before final finishing.
 3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
 4. Floated finish:
 - a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
 - b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.

- 1) Use wood or cork float.
- c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
 - a. Refloat slab immediately to a uniform texture.
6. Troweled finish:
 - a. Float finish surface to true, even plane.
 - b. Power trowel, and finally hand trowel.
 - c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
 - d. Perform additional trowelings by hand after surface has hardened sufficiently.
 - e. Final trowel when a ringing sound is produced as trowel is moved over surface.
 - f. Thoroughly consolidate surface by hand troweling.
 - g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
 - 1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 - h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.
7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
8. Underside of concrete slab finish:
 - a. Match finish as specified for adjacent vertical surfaces.
 - b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

- A. Tolerances:
 1. Finished floor slabs:
 - a. Provide Floor Flatness (F_F) and Floor Levelness (F_L) in accordance with ACI 117.
 - 1) Measure in accordance with ASTM E1155.
 - b. Slabs not indicated to be sloped:
 - 1) F_F : Equal or greater than 35.
 - 2) F_L : Equal or greater than 25.
 - c. Slabs indicated to be sloped or curved:
 - 1) Measure in accordance with ASTM E1486.
 - 2) Provide slopes or curves as indicated on the Drawings.
 - d. Slabs indicated to receive polished concrete floor:
 - 1) F_F : Equal or greater than 45.
 - 2) F_L : Equal or greater than 35.
 - 3) Refer to Room Finish Schedule on Drawings.
 2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
 - a. Gap between a 10 FT straightedge placed anywhere and the finished surface shall not exceed:
 - 1) Class A tolerance: 1/4 IN.
 - 2) Class B tolerance: 3/8 IN.
 - 3) Class C tolerance: 1/2 IN.
 - b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 IN.
- B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
 1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

- C. Provide services of manufacturer's technical representative:
1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
 2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
 3. Manufacturer's representative shall be present for installation of:
 - a. Dry-shake Hardener.
 - b. Heavy-duty Metallic Aggregate Topping.

3.4 PROTECTION

- A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 HRS following installation of sealer.

3.5 CONCRETE FINISH SCHEDULE

DRAWING NO.	STRUCTURE NAME	SURFACE TO BE FINISHED	FINISH NO.

END OF SECTION

SECTION 03 41 33
PRECAST AND PRESTRESSED CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Precast and prestressed concrete.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. HB, Standard Specifications for Highway Bridges.
 - 2. American Concrete Institute (ACI):
 - a. 211.2, Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
 - b. 318, Building Code Requirements for Structural Concrete.
 - 3. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - c. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - d. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - e. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - f. C33, Standard Specification for Concrete Aggregates.
 - g. C150, Standard Specification for Portland Cement.
 - h. C330, Standard Specification for Lightweight Aggregates for Structural Concrete.
 - i. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - j. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
 - 4. American Welding Society (AWS):
 - a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
 - b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
 - c. D1.1, Structural Welding Code - Steel.
 - d. D1.4, Structural Welding Code - Reinforcing Steel.
 - e. D1.6, Structural Welding Code - Stainless Steel.
 - 5. Occupational Safety and Health Administration (OSHA).
 - 6. Precast/Prestressed Concrete Institute (PCI):
 - a. MNL 116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
 - b. MNL 120, Design Handbook - Precast and Prestressed Concrete.
- B. Qualifications:
 - 1. Provide precast and prestressed concrete units produced by an active member of PCI.
 - 2. Plant to be certified by the Precast/Prestressed Concrete Institute, Plant Certification Program, as applicable:
 - a. Certification Code C1: Precast Concrete Products.

- b. Certification Code C2: Precast Hollow Core and Repetitive Products.
- c. Certification Code C3: Prestressed Straight Strand Structural Members.
- d. Certification Code C4: Prestressed Deflected Strand Structural Members.
- e. Plant shall have been certified within past year from bid date.
- 3. Plant shall be certified by IAS and shall be acceptable to the Building Code Official to assure compliance with approved fabricator Special Inspection requirements in accordance with the building code.
 - a. Plants that are not certified by IAS or not acceptable to the Building Code Official may be acceptable to work on the Project, provided:
 - 1) Plant meets all remaining qualifications.
 - 2) Contractor reimburses the Owner the cost of Special Inspection services.
- 4. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a minimum of three years.
- 5. Assure manufacturer's testing facilities meet requirements of ASTM E329.
- 6. Welding operators and processes to be qualified in accordance with:
 - a. AWS D1.1 for welding steel shapes and plates.
 - b. AWS D1.4 for welding reinforcing bars.
- 7. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.
- 8. Engineer for all precast or prestressed members: Professional Engineer licensed in the State of Washington.
 - a. Engineer to have minimum five years of experience in design of precast and prestressed members with scope similar to this Project.
- 9. Precast erector:
 - a. Minimum three years of experience with projects of similar size and complexity.

1.3 DEFINITIONS

- A. Slabs: May refer to hollow core slabs or solid flat slabs, prestressed or non-prestressed.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Sizes, types and manufacturer of bearing pads.
 - d. Hardware to be utilized to support suspended appurtenances.
 - 3. Shop Drawings and erection plans for precast units, their connections and supports showing:
 - a. Member size and location.
 - b. Size, configuration, location and quantity of reinforcing bars and prestressing strands.
 - c. Initial prestress forces.
 - d. Size and location of openings verified by Contractor.
 - e. Size, number, and locations of embedded metal items and connections.
 - f. Required concrete strengths.
 - g. Identification of each unit using same standard marking numbers as used to mark actual units.
 - 4. Calculations for members and connections designed by fabricator.
 - a. Calculations to be sealed by a professional Structural Engineer registered in the State in which the Project is constructed.
 - b. Perform calculations using the dead load of the members plus the superimposed uniform and concentrated loads shown on the Drawings and indicated in this Specification Section.

- c. Indicate the following:
 - 1) Design for maximum moment, maximum shear and maximum torsion.
 - 2) Final top and bottom flexural stresses resulting from the stresses due to maximum moment and prestress force.
 - 3) Ultimate moment capacity.
 - 4) Final top and bottom flexural stresses, ultimate moment capacity, and ultimate shear capacity, if affected, for members with reduced cross sections due to openings or penetrations.
 - 5) When required on Drawings, a check for no tension in top and bottom of members due to prestress force and member dead load plus superimposed loads indicated on Drawings and in this Specification Section.
 - 6) Column design for maximum axial load and maximum moment.
- 5. Submit test results, when so required on Drawings, showing that embedded connection items will adequately support the indicated loads.
 - a. Connection items to have an ultimate load capacity of at least two times the required indicated load.
- 6. Concrete mix design(s) including submittal information defined in Specification Section 03 05 05.
- 7. Fabricator's quality control documentation for special inspections as required by the building code Chapter 17.
- 8. Copies of source quality control tests.
- 9. Certification of manufacturer's testing facility qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Headed studs and deformed bar anchors:
 - a. Nelson Stud Welding Div., TRW, Inc.
 - b. KSM Division, Omark Industries.
 - 2. Bearing pads:
 - a. JVI, Inc.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Embedded Steel Plates and Shapes:
 - 1. ASTM A36.
- B. Bearing Pads:
 - 1. Under slabs:
 - a. Plastic bearing strips.
 - b. Minimum compressive strength: 8,000 PSI with no fracture at 26,000 PSI.
 - c. Korolath of New England, Inc., or equal.
 - 2. For all other locations:
 - a. Random, fiber-reinforced elastomeric pads.
 - b. Preformed, randomly oriented synthetic fibers set in elastomer.
 - c. Capable of supporting a compressive stress of 3000 PSI with no cracking, splitting, excessive bulging or delaminating in the internal portions of the pad.
 - d. Size pad to keep a minimum stress 200 PSI under minimum dead load.
 - e. Masticord as manufactured by JVI, Inc., or equal.

- C. Cement:
 - 1. Comply with ASTM C150, Type I or III.
 - 2. Type II cement to be used in the following precast units:
 - a. Precast weir troughs.
- D. Aggregates for Normal Weight Concrete:
 - 1. ASTM C33 with coarse aggregate meeting the gradation for Size 67 as stated in ASTM C33.
 - 2. Provide aggregates approved for bridge construction by the State Highway Department in the state where the precast units are fabricated or in the state where the Project is located.
 - 3. All fine aggregate to be natural not manufactured.
- E. Aggregates for Lightweight Concrete:
 - 1. ASTM C330 with 3/4 IN maximum size coarse aggregate.
 - 2. All fine aggregate to be natural not manufactured.
- F. Water:
 - 1. Potable, clean.
 - 2. Free of oils, acids, and organic matter.
- G. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.
- H. Prestressing Strands:
 - 1. Either 250K or 270K high tensile strength uncoated seven wire strand.
 - 2. Manufacture and test strands in accordance with ASTM A416.
- I. Reinforcing Steel and Welded Wire Reinforcement: See Specification Section 03 21 00.
- J. Headed Studs:
 - 1. ASTM A108.
 - 2. Minimum yield strength: 50,000 PSI.
 - 3. Minimum tensile strength: 60,000 PSI.
- K. Deformed Bar Anchors:
 - 1. ASTM A496 or ASTM A1064.
 - 2. Minimum tensile strength: 80,000 PSI.
 - 3. Minimum yield strength: 70,000 PSI.
- L. Electrodes:
 - 1. E70 series conforming to AWS A5.1/A5.1M or AWS A5.5/A5.5M for welding steel shapes and plates.
 - 2. E90 series conforming to AWS A5.5/A5.5M for welding rebar.
- M. Concrete sand cement grout in keyways between slabs.
 - 1. See Specification Section 03 31 30.

2.3 DESIGN

- A. General Design Requirements:
 - 1. Design units and connections in strict accordance with ACI 318 and the PCI MNL 120.
 - 2. Design units for spans, dead load of members, dead and live loads indicated on the Drawings with concentrated loads placed in their actual locations.
 - a. Verify weights and locations of concentrated loads.
 - 3. Design units taking into account reduced cross section at openings and penetrations.
 - 4. Provide all reinforcing in units as indicated.
 - a. Where not indicated, design and provide all reinforcing and prestressing strands subject to approval of Engineer.

5. Due to presence of corrosive atmosphere, design prestressed members where indicated on Drawings for no tension in top and bottom of members resulting from loads indicated on Drawings and in this Specification Section.
6. Design connections to allow rotation and/or movement as appropriate to avoid damage to connections, supporting members, joint sealants and other building components.
7. Design double tee flanges to carry all dead and live loads to be placed thereon.
 - a. Do not place concentrated equipment loads on flanges but support the loads on the double tee legs.

2.4 MIXES

- A. See Specification Section 03 31 31.
- B. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

2.5 FABRICATION

- A. Do not fabricate units until Shop Drawings have been approved by Engineer and returned to Contractor and support locations have been field verified by Contractor.
- B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with both PCI MNL 116 and PCI MNL 120.
- C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.
- D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.
- E. Finish all repairs smooth and to match adjacent surface texture and color.
- F. Where units are to receive concrete topping, provide units having heavy broom finish on top surface for bond.
 1. Provide roughness of top surface to provide bond with topping and design for horizontal shear at topping and unit interface in accordance with requirements of ACI 318, Horizontal Shear Strength paragraph.
 2. Make all other surfaces smooth.
- G. Incorporate embedded plates, angles, and flange welding strips into members at time of manufacture.
 1. Provide embedded items as shown on the Drawings unless prior approval is received from Engineer to do otherwise.
 2. Provide flange welding strips on all flanged edges of all double tee units as indicated on Drawings.
 3. Space strips as shown on Drawings.
 4. Cast lifting handles into units at or near support points.
 - a. Remove lifting handles after units are erected.
- H. Cast openings larger than 6 IN SQ or 6 IN DIA in units at time of manufacture.
 1. Make smaller openings by neat cutting or neat drilling by trades requiring them.
 2. Coordinate sizes and locations of all openings before fabrication of units.
- I. Make provisions for support of suspended ceilings, lighting fixtures, ducts, piping, conduits and other suspended work.
 1. When drilled expansion bolts or powder-driven fasteners are approved for use, coordinate prestress strand location with prestress concrete member supplier so that drilled expansion bolts or powder-driven fasteners do not hit or are drilled or driven into prestress strands.
 2. Install powder-driven fasteners by means of a low velocity powder-actuated tool complying with requirements of OSHA.
 - a. Assure that the load to be supported by each in place drilled expansion bolt or powder-driven fastener does not exceed the maximum allowable load recommended by the bolt or fastener manufacturer for the concrete strength encountered and for the type, size and embedment length of expansion bolt or driven fastener installed.

- J. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.
- K. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.
- L. Minimum concrete compressive strength at time of strand release: 3500 PSI.
- M. Mark each unit as indicated on the erection plans.
 - 1. Place mark on non-exposed-to-view surface.
- N. Coat or finish ends of exposed prestressing strands to prevent rusting.
- O. Fabricate the following types of precast and prestressed units (all units to be made with normal weight concrete unless noted otherwise on Drawings):
 - 1. Prestressed double tees of sizes indicated on Drawings.
 - a. Weight of double tees, based on the nominal section width, not to exceed following:
 - 2. Prestressed hollow core slabs of sizes indicated.
 - a. Weight of hollow core slabs not to exceed the following:
 - 3. Precast items shown on Drawings including but not limited to:
 - a. Lintels.
 - b. Splash blocks.
 - 4. Precast concrete beams and columns as shown on Drawings:
 - a. Reinforce as indicated.
 - 1) If reinforcement is not indicated, design and provide reinforcement as required to support maximum torsion, shear, moment and axial loads.
 - b. See the Specific Design Requirements paragraph in the DESIGN Article in PART 2 of this Specification Section
 - c. Provide beam and column connections as indicated on Drawings and as required to support all loads subject to Engineer's approval.

2.6 SOURCE QUALITY CONTROL

- A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03 05 05 for concrete placed during fabrication.
 - 1. Results of strength tests to be sent immediately to Engineer, Contractor and Owner.
 - 2. Test reports to indicate units they represent.
- B. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.
- C. Conduct tests on precast concrete using the following procedures:
 - 1. If the precast manufacturer's quality control program requires more frequent or more stringent testing requirements, the manufacturer's quality control program will take precedence over the specific type of test.
 - a. Precast manufacturer to employ services of an independent testing laboratory to perform concrete testing for manufacturer's production procedures (not listed below) and quality control program.
 - 2. If the precast fabrication plant is not certified by IAS and acceptable to the Building Code Official, Owner will employ and pay for precast concrete production special inspection.
 - a. Coordinate with Owner's special inspector.
 - 1) Provide minimum 7 calendar days notice prior to the start of fabrication.
 - 2) Provide minimum 24 HRS notice prior to fabrication of any precast members.
 - 3. If precast fabrication plant is certified by IAS and acceptable to the Building Code Official, perform concrete tests as specified in Section 03 05 05. Frequency of tests: Per PCI MNL-116 or PCI MNL-117 as applicable.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify acceptability and location of supports to receive units.
 - 1. Check bearing surfaces to determine that they are level and uniform.
- B. Verify compressive strengths of concrete and masonry supports.
 - 1. Do not start erection of units until supports have reached their 28 day required compressive strengths.

3.2 ERECTION

- A. Sequence erection to provide a balance of loads across beams and columns.
- B. Give consideration to possible lack of stability or capacity of partially completed frame or structure.
- C. Contractor to be responsible for guying, shoring, and bracing of frame, walls and individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.
- D. Use only erection equipment adequate for placing units at lines and elevations indicated on Drawings.
 - 1. Do not damage units or existing construction during erection.
 - 2. Erect units using lifting handles cast into the units.
- E. Place each leg of all double tees on a 3/8 IN thick bearing pad held 1 IN back from edge of support.
 - 1. Pad dimensions equal to length of bearing -1 IN x bearing width +2 IN.
- F. Place slabs on continuous 1/4 IN thick bearing pad so that width equals bearing length -1 IN.
- G. Provide a 1/2 IN thick bearing pad on the top of all precast concrete columns.
- H. Pad to cover entire top surface of column except hold pad back 1 IN from face of column all around.
- I. Weir Trough:
 - 1. Anchor weir troughs to supports as indicated on Drawings.
 - 2. Provide continuous 3/8 IN thick bearing pad under troughs at support.
 - 3. Hold back pads 1 IN from edge of support.
- J. After erection, verify that there is no direct contact between bottom of units and supporting members.
 - 1. Where direct contact occurs, install additional layers of bearing material to raise units off supports.
- K. Lintels:
 - 1. Length of lintel bearing on supports to be as indicated on Drawings.
 - a. If not indicated, minimum length of lintel bearing to be 8 IN.
 - 2. Fill masonry cells under lintel bearing with masonry grout and reinforce cells as indicated.
 - 3. Provide minimum 3/8 IN thick full bed joint of masonry mortar between underside of lintel and top surface of grouted masonry for complete lintel bearing length.
- L. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.
- M. Fill all keyways between slabs with concrete sand cement grout.
 - 1.
- N. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections.
 - 1. See Specification Section 09 96 00.

3.3 FIELD QUALITY CONTROL

- A. Testing and Special Inspections: See Section 01 45 33.
- B. Causes for rejection of units include, but are not necessarily limited to the following:
 - 1. Cracked units.
 - 2. Chipped, broken, or spalled edges.
 - 3. Units not within allowable casting tolerances.
 - 4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
 - 5. Non-uniform finish or appearance.
 - 6. Low concrete strength.
 - 7. Improperly placed embedded items and/or openings.
 - 8. Exposed wire mesh, reinforcing or prestressing strands.

END OF SECTION



DIVISION 05

METALS



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SECTION 05 12 00

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Structural steel, including the fabrication and erection of support and bracing members, including connections.
 - 2. Connection detail design as required.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 15 19 - Anchorage to Concrete.
 - 4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Institute of Steel Construction (AISC):
 - a. 303, Code of Standard Practice for Steel Buildings and Bridges.
 - b. 360, Specifications for Structural Steel Buildings.
 - c. Quality Certification Program for Fabricators.
 - 2. American Society of Mechanical Engineers (ASME):
 - a. B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
 - 3. ASTM International (ASTM):
 - a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
 - b. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - c. A36/A36M, Standard Specification for Carbon Structural Steel.
 - d. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - e. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - f. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - i. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - j. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - k. A992/A992M, Standard Specification for Structural Steel Shapes.
 - l. A1064/A1064M, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - m. F436, Standard Specification for Hardened Steel Washers.
 - n. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
 - o. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

- p. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- 4. American Welding Society (AWS):
 - a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
 - b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
 - c. A5.17/A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
 - d. A5.18/A5.18M, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
 - e. A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
 - f. A5.23/A5.23M, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
 - g. A5.28/A5.28M, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
 - h. A5.29/A5.29M, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
 - i. D1.1/D1.1M, Structural Welding Code - Steel.
 - 1) Steel stud connectors and their installation to comply with requirements of AWS D1.1/D1.1M.
- 5. National Institute of Steel Detailing (NISD).
- 6. Research Council on Structural Connections (RCSC):
 - a. Specification for Structural Joints Using High-Strength Bolts.
- B. Qualifications:
 - 1. Steel fabricator:
 - a. Minimum of 5 years of experience in fabrication of structural steel or participate in the AISC Certification program and is designated an AISC Certified Plant, Category [BU (formally known as STD), SBR] at time of bid.
 - b. Fabricator plant quality control and inspection program: Meet requirements of the building code and/or be an Approved Fabricator.
 - c. Plants that are not an Approved Fabricator may be acceptable, provided:
 - 1) Plant meets all remaining qualifications.
 - 2) Contractor reimburses the Owner the cost of required Special Inspection services.
 - 2. Steel erector:
 - a. Minimum of 5 years of experience in erection of structural steel similar in the scope of this project or certified as CSE under the AISC Quality Certification Program.
 - b. With an active and enforced quality assurance program in place, as described in the applicable Codes.
 - 3. Qualify welding procedures and welding operators in accordance with AWS.

1.3 DEFINITIONS

- A. Owner: May mean the Owner's Designated Representative for Construction as defined by the AISC 303.
- B. Galvanizing: Hot-dipped galvanizing per ASTM A153/A153M and/or ASTM A123/A123M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by aforementioned standards.
- C. Approved Fabricator: Approved by the Building Official to perform the building code required Special Inspections.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Detailed supplemental specification relating to load indicator washers or high-strength bolts.
 - 1) Alternate design for Engineer approval (submitted at Contractor's option if desired by Contractor for use).
 - d. Source and certification of quality for high-strength bolts, nuts and washers.
 - 3. Fabrication and/or layout drawings:
 - a. Prepare Shop Drawings under NISD Quality Procedures Program certification.
 - b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
 - 1) All Shop Drawings must be checked and signed "approved" before submittal.
 - 2) Show all cuts, copes, and holes.
 - 3) Indicate all shop and field bolts.
 - 4) Indicate all shop and field welds using AWS symbols.
 - c. Prepare complete erection drawings showing the location and marks of all pieces.
 - 1) Copies of up-to-date erection drawings shall accompany the Shop Drawings.
 - 2) Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
 - d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
 - 4. Certifications:
 - a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
 - b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
 - c. Welder qualification data and prequalified procedures.
 - d. Special Inspections reports.
 - e. Source Quality Control Documentation, including certificate of compliance stating that the work performed in the fabrication shop was done in accordance with the approved construction documents.
 - 1) Certification is required only if the fabricator is fabricator approved by the Building Official.
 - 5. Test reports:
 - a. Certified copies of mill tests.
 - b. Manufacturer's load test and temperature sensitivity data for post-installed anchor bolts.
 - c. Test reports for all structural steel work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store steel members above ground on skids or other supports.
 - 1. Keep free of dirt and other foreign material and protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. High-strength bolts:
 - a. Portland Bolt and Manufacturing Company.

- b. Lewis Bolt & Nut Company.
 - c. Nucor Fasteners.
 - d. St. Louis Screw and Bolt Company.
 - 2. Load indicator washers for high-strength bolts:
 - a. Portland Bolt and Manufacturing Company.
 - b. Mid-South Bolt and Screw Co., Inc.
 - c. J and M Turner, Inc.
 - 3. Alternate design high-strength bolts:
 - a. T. C. Bolt Corporation.
 - b. Construction Fastener Systems Division of Bristol Machine Company.
 - c. LeJuene Bolt Co.
 - 4. Headed studs and deformed bar anchors:
 - a. Nelson Stud Welding Division, TRW, Inc.
 - b. Stud Welding Products, Inc.
 - 5. Mechanical anchor bolts:
 - a. See Section 03 15 19.
 - 6. Adhesive anchors bolts:
 - a. See Section 03 15 19.
 - 7. Anchor bolt sleeves:
 - a. Sinco/Wilson.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
 - 1. All W-shapes and WT-shapes: ASTM A992/A992M.
 - 2. All other plates, bars and rolled shapes: ASTM A36/A36M.
- B. Pipe: ASTM A53/A53M, Grade B (Type E or S) (Fy=35).
- C. Hollow Structural Sections (HSS):
 - 1. Round: ASTM A500/A500M, Grade B (Fy=42).
 - 2. Square or rectangular: ASTM A500/A500M, Grade B (Fy=46).
- D. High-Strength Bolts, Nuts and Washers:
 - 1. ASTM F3125, Grade A325 with ASTM A563 nuts galvanized:
 - 2. High-strength bolts:
 - a. Provide two ASTM F436 washers for all bolts galvanized.
 - b. Provide beveled washers at connections of sloped/tapered sections.
 - 3. High-strength bolts with compressible washer type direct tension indicators (DTI), ASTM F959.
 - a. Provide at Contractor's option and subject to approval of Engineer.
 - 4. Alternate high-strength design: Provide at Contractor's option and subject to approval of Engineer.
- E. Bolts, Non-high Strength: ASTM A307, Grade A.
- F. Threaded Rod: ASTM F1554, Grade 36.
- G. Washers, Plain (for Non-high Strength Bolts): ASME B18.22.1, Type B.
- H. Welding Electrodes:
 - 1. Shielded metal arc: AWS A5.1/A5.1M or AWS A5.5/A5.5M, E70XX or E801X-X.
 - 2. Submerged arc: AWS A5.17/A5.17M or AWS A5.23/A5.23M, F7XX-EXXX or F8XX-EXXX-XX.
 - 3. Gas metal arc: AWS A5.18/A5.18M, E70S-X or E70U-1 or AWS A5.28/A5.28M, ER80S-XX, E80C-XXX.
 - 4. Flux cored arc: AWS A5.20/A5.20M, E7XT-X (except 2, 3, 10, GS), AWS A5.29/A5.29M, E7XT-X or E8XTX-X, E8XTX-XM.

- I. Anchor Rods and Bolts:
 - 1. See Section 03 15 19.
- J. Headed Studs and Deformed Bar Anchors:
 - 1. Headed studs:
 - a. ASTM A108, complying with AWS D1.1/D1.1M, Section 7, Type B; minimum yield strength 50,000 PSI, minimum tensile strength 60,000 PSI.
 - b. Uniform diameter.
 - c. Heads: Concentric and normal to shaft.
 - d. Weld end: Chamfered and solid flux.
 - 2. Deformed bar anchor:
 - a. ASTM A1064/A1064M, complying with AWS D1.1/D1.1M, Section 7, Type C.
 - b. Minimum yield strength: 70,000 PSI.
 - c. Minimum tensile strength: 80,000 PSI.
 - d. Straight, unless indicated otherwise.
 - e. Solid flux.
 - 3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.
- K. Nonshrink Grout: See Specification Division 03.
- L. Crane Rails:
 - 1. Controlled-cooled, open-hearth carbon steel ASCE (American Society of Civil Engineers) rails per ASTM A2, Class A, #1 rails, unless noted otherwise, of size and weight indicated.
 - a. Furnish rails with milled tight end joints suitable for crane service, with standard drilling, removable end stops and all related accessories required, including:
 - 1) Joint bars: Match rail section and properties, drilled to match rail drilling.
 - 2) Joint bar bolts and nuts: High strength.
 - 3) Hardened washer: ASTM F436 for bar bolts.
 - 4) Except as indicated otherwise, two-bolt type fixed or floating rail clamps to suit the conditions, of forged or pressed steel, complete with Grade A325 bolts, reversible fillers, and self-locking nut or nut and lock washer.
- M. Mechanical and Adhesive Anchor Bolts for Fastening to Concrete:
 - 1. See Specification Section 03 15 19.

2.3 FABRICATION

- A. Comply with requirements of applicable building code and AISC 360 with modifications and additional requirements specified herein.
 - 1. Identify high-strength steel material in fabricated members in accordance with ASTM A6/A6M.
- B. Minimize the amount of field welding.
 - 1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
 - 2. Shop connections: Bolted with high-strength bolts or welded.
- C. Connection Details:
 - 1. Provide as a minimum, two, 3/4 IN DIA, high-strength bolts for all bolted connections unless otherwise specified.
- D. Provide bearing type connections for all bolted connections, unless otherwise noted.
- E. Field Connections:
 - 1. Provide bolts for all field connections except where shown otherwise on the Drawings.
 - 2. Use high-strength bolts unless shown or specified otherwise.
 - 3. Use of high-strength bolts: Conform to RCSC Specification for Structural Joints Using High-Strength Bolts.
 - 4. Unfinished bolts may be used for attaching stair treads to stringers.

5. If structural steel details (field welds versus shop welds, etc.) shown on design Drawings are not compatible with selected erection procedures, submit proposed modifications for review.
 6. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.
- F. Accurately mill column end bearing surfaces to true plane.
- G. Fabricate and erect beams with non-specified camber in accordance with AISC 360, Chapter L1.
- H. Cut, drill, or punch holes at right angles to surface of metal.
1. Do not make or enlarge holes by burning.
 2. Make holes clean cut, without torn or ragged edges.
 3. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
 4. Provide holes in members to permit connection of work of other trades or contractors.
- I. Make allowance for draw in all cross bracing to provide small amount of initial tension in members.
- J. Make splices only where indicated or where approved.
- K. Wall Girts:
1. Extend past columns and miter ends unless noted otherwise.
 2. Connect girts to each other at corners unless noted otherwise.
- L. Cope at 45 DEG, corners of stiffener plates at junction of member flanges with webs.
- M. Flame cut bevels for welds, provided such cutting is done automatically.
1. Leave free of burrs and slag by grinding or planing the cut edges.
- N. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8 IN radius.
- O. Tolerances (unless noted otherwise on Drawings):
1. When material received from the mill does not satisfy ASTM A6/A6M tolerances for camber, profile, flatness or sweep, Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC 360.
 2. Fabrication tolerance:
 - a. Member length:
 - 1) Both ends finished for contact bearing: 1/32 IN.
 - 2) Framing members: 30 FT or less: 1/16 IN, Over 30 FT: 1/8 IN.
 - b. Member straightness:
 - 1) Compression members: 1/1000 of axial length between points laterally supported.
 - 2) Non-compression members: ASTM A6/A6M tolerance for wide flange shapes.
 - c. Specified member camber (except compression members):
 - 1) 50 FT or less: -0/+1/2 IN.
 - 2) Over 50 FT: -0/+1/2 IN (+1/8 IN per 10 FT over 50 FT).
 - 3) Members received from mill with 75 PCT of specified camber require no further cambering.
 - 4) Fabricate beams/trusses without specified camber so after erection, camber is upward.
 - 5) Measure camber in fabrication shop in unstressed condition.
 - d. Use filler plates at bolted splices to take up depth deviation.
 - 1) At welded joints, adjust weld profile to conform to variation in depth.
 - 2) Slope weld surface per AWS requirements.
 - e. Free finished members from twists, bends and open joints.
 - 1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

2.4 WELDING

- A. Comply with AWS D1.1/D1.1M, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
 - 1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
- B. Test and qualify welders, welding operators and tackers in compliance with AWS D1.1/D1.1M for position and type of welding to which they will be assigned.
 - 1. Conduct tests in presence of approved testing agency.
 - 2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.
- C. Before Starting Welding:
 - 1. Carefully plumb and align members in compliance with specified requirements.
 - 2. Fully tighten all bolts.
 - 3. Comply with AWS D1.1/D1.1M, Section 5 for assembly and surface preparation.
 - 4. Preheat base metal to temperature stated in AWS D1.1/D1.1M.
 - a. When no preheat temperature is given in AWS D1.1/D1.1M and base metal is below 50 DEGF, preheat base metal to at least 70 DEGF.
 - b. Maintain temperature during welding.
 - c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
 - d. Maintain this temperature during welding.
 - 5. Mark welds with an identifying mark unique to each welder.
- D. Make flange welds before making web welds.
- E. Where groove welds have back-up plates, make first three passes with 1/8 IN round electrodes.
 - 1. Use backup plates in accordance with AWS D1.1/D1.1M, extending minimum of 1 IN either side of joint.
- F. Flame cut edges of stiffener plates at shop or field butt weld.
 - 1. Do not shear.
- G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
- H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS D1.1/D1.1M.
- I. Do not perform welding when ambient temperature is lower than 0 DEGF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.
- J. Headed Studs and Deformed Bar Anchors:
 - 1. Automatically end welded in accordance with the AWS D1.1/D1.1M and manufacturer's recommendations.
 - 2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.
- K. Test in-place studs in accordance with requirements of AWS D1.1/D1.1M to ensure satisfactory welding of studs to members.
 - 1. Replace studs failing this test.
- L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.
 - 1. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.5 SHOP COATING

- A. Refer to Specification Section 09 96 00 and coordinate shop primer, surface preparation and coating with field applied primers and coatings where specified.
- B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.
- C. Do not coat following surfaces:
 - 1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
 - 2. All other members for which no coating is specified.
 - 3. Contact surfaces at bolted slip-critical connections, unless surface condition conforms to the RCSC Specification for Structural Joints Using High-Strength Bolts, Part 3.2.2.
- D. Clean thoroughly all surfaces not coated before shipping.
 - 1. Remove loose mill scale, rust, dirt, oil and grease.
 - 2. Protect machined surfaces.

2.6 SOURCE QUALITY CONTROL

- A. Special Inspection and Testing:
 - 1. See Specification Section 01 45 23.
 - 2. If the fabricator is not an Approved Fabricator, Owner will employ the services of an independent testing agency to inspect and test structural steel shop work for compliance with Specifications.
 - a. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
 - 3. Contractor responsible for testing to qualify shop welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
- B. Approved Fabricator or Testing Agency Responsibilities:
 - 1. Inspect shop and field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
 - a. Visually inspect all welds.
 - b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant.
 - c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
 - 2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
 - a. Verify proper pretension for slip-critical bolted connection only.
 - b. Verify direct tension indicator gaps for slip-critical bolted connection only.
 - 3. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.
 - 4. Prepare and submit inspection and test reports to Engineer.

2.7 GENERAL

- A. Contractor is solely responsible for safety.
 - 1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
 - 2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete, e.g., until slabs, decks, bracing or rigid connections are installed.
 - 3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
 - 4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

- B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment, is the responsibility of the Contractor.
 - 1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
 - 2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
 - 3. Design of the temporary bracing system and consideration of the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades, is the Contractor's responsibility.
 - a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
 - 4. Remove and dispose of all temporary work and facilities off-site.
- C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
 - 1. Report defects in work-in-place which may influence satisfactory completion of the work.
 - 2. Absence of such notification will be construed as acceptance of work-in-place.
- D. Field Measurement:
 - 1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
 - 2. Contractor is responsible for the accurate fit of the work.
- E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
 - 1. Notify Engineer of any errors or deviations found by such checking.

PART 3 - EXECUTION

3.1 ERECTION

- A. Framing member location tolerances after erection shall not exceed the framing tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
- B. Erect plumb and level; introduce temporary bracing required to support erection loads.
- C. Use light drifting necessary to draw holes together.
 - 1. Drifting to match unfair holes is not allowed.
- D. Welding:
 - 1. Conform to AWS D1.1/D1.1M and requirements of this Specification Section.
 - 2. Join two (2) sections of steel of different ASTM designations using welding techniques in accordance with a qualified AWS D1.1/D1.1M procedure.
- E. Shore existing members when unbolting of common connections is required.
 - 1. Use new bolts for rebolting connections.
- F. Clean stored material of all foreign matter accumulated during erection period.
- G. Clean bearing and contact surfaces before assembly.
- H. Set beam and column base and bearing plates accurately, as indicated, on nonshrink grout.
 - 1. Set and anchor each base plate to proper line and elevation.
 - 2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
 - a. Use same metal as base plate.
 - b. Cut off protrusions of wedges and shims flush with edge of base plate.

3. Fill sleeves around anchor bolts with nonshrink grout.
 4. Pack grout solidly between bottom of plate and bearing surface.
 5. Refer to Specification Division 03.
- I. Cast-in-place Anchor Bolts:
1. See Specification Section 03 15 19.
- J. Install high strength bolts with hardened washers.
1. Install and tighten in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.
 2. Coordinate installation with inspection.
 - a. Do not start installation until coordination with Testing Agency is complete.
 3. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
 4. Slip-critical connections:
 - a. Perform calibration testing for all methods of installation of high-strength bolts in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.2.
 - b. Turn-of-nut tightening:
 - 1) Inspector shall observe the pre-installation verification testing.
 - 2) Subsequently, ensure by routine observation that the bolting crew properly rotates the turned element relative to the unturned element by the amount specified.
 - 3) Alternatively, when fastener assemblies are match-marked after the initial fitup of the joint but prior to pretensioning, visual inspection after pretensioning is permitted in lieu of routine observation.
 - c. Calibrated wrench tightening: Calibrate on a daily basis.
 - d. Direct tension indicator tightening: If previously approved by Engineer.
 - e. Installation of alternate design bolts: If previously approved by Engineer.
 5. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.
- K. Do not use gas cutting to correct fabrication errors.
1. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt.
 - a. Drill new holes if the connections require new holes.
 - b. Make no such corrections without prior approval of the Engineer.
 2. Burning of holes is not permitted.
- L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.
- M. Tighten and leave in place erection bolts used in welded construction.
- N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.
- O. After bolts are tightened, upset threads of non-high strength bolts and anchor bolts to prevent nuts from backing off.
- P. After Erection:
1. Grind smooth all sharp surface irregularities resulting from field cutting or welding.
 2. Power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.
- Q. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

- A. Special Inspection and Testing:
1. See Specification Section 01 45 23.
 2. Special Inspection to be in accordance with the building code.

3. Special Inspection is required for:
 - a. Material verification of high-strength bolts, nuts, and washers.
 - 1) Frequency: All high-strength bolts, prior to being covered up or substantial completion.
 - b. Inspection of high-strength boltings:
 - 1) Frequency:
 - a) All high-strength bolts, prior to being covered up or substantial completion.
 - b) Pretensioned and slip-critical joints using turn-of-nut without match marking or calibrated wrench methods of installation require continuous inspection.
 - c. Material verification of structural steel.
 - 1) Frequency: Prior to being covered up or substantial completion,
 - d. Material verification of weld filler materials.
 - 1) Frequency:
 - a) Prior to welding on site.
 - b) Randomly thereafter.
 - e. Inspection of welding.
 - 1) Frequency:
 - a) Visually inspect all welds.
 - b) In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant or magnetic particle.
 - c) Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
 - f. Inspect structural steel which has been erected.
 - 1) Frequency: Prior to members being covered up or substantial completion.
 - g. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.
- B. Erected Framing Tolerance, unless noted otherwise on the Drawings:
 1. Do not exceed cumulative effect of rolling, fabrication and erection tolerance for overall finished dimensions.
 2. Erection tolerances are defined relative to member working points and working lines as follows:
 - a. Actual centerline of top flange or surface at each end for horizontal members.
 - b. Actual center of member at each end for all other members.
 - c. Other points may be used, providing they are based on these definitions.
 - d. Working line is straight line connecting member working points.
 3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified.
 - a. Provide "adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members with adjustable connections to supporting structural framing.
 4. Certification by steel erector:
 - a. Certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified.
 - b. Provide certification upon completion of any part of work.
 - c. Provide certification prior to start of work by other trades that may be supported; attach to structural steel work.

3.3 CLEANING AND REPAIR OF SHOP PRIMER PAINT

- A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
 1. Touchup coatings to comply with Specification Section 09 96 00.

END OF SECTION

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SECTION 05 14 00
STRUCTURAL ALUMINUM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Structural aluminum including the fabrication and erection of framing and bracing members, including connection design as required.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 15 19 - Anchorage to Concrete.
 - 4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Aluminum Association (AA):
 - a. ADM 1, The Aluminum Design Manual.
 - b. DAF 45, Designation System for Aluminum Finishes.
 - 2. American Institute of Steel Construction (AISC):
 - a. 325, Manual of Steel Construction.
 - 3. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - c. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
 - d. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - e. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - f. F467, Standard Specification for Nonferrous Nuts for General Use.
 - g. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use.
 - h. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - i. F594, Standard Specification for Stainless Steel Nuts
 - 4. American Welding Society (AWS):
 - a. D1.2, Structural Welding Code - Aluminum.
- B. Qualifications:
 - 1. Minimum of 5 years of experience in fabrication of structural aluminum.
 - 2. For welding aluminum:
 - a. Qualify welding procedures and welding operators in accordance with AWS D1.2.
 - b. Welding operators to have been qualified during the 12-month period prior to commencement of welding.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Fabrication and/or layout drawings:
 - a. Erection plans and details of each piece including connection details:
 - 1) Show all cuts, copes and holes.

- 2) Indicate all shop welds using AWS symbols.
 - 3) Indicate all shop and field bolts.
- b. Complete shop drawings for all of the work showing clearly all pieces, details, connections, materials and shop-applied coatings.
- c. Prepare complete erection drawings showing the location and marks of all pieces.
- 3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
- 4. Certifications.
 - a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
 - b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
- 5. Test reports.
 - a. Certified copies of material mill tests.
 - b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolt and adhesive anchor bolts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Mechanical anchor bolts: See Specification Section 03 15 19.
 - 2. Adhesive anchor bolts: See Specification Section 03 15 19.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Alloy 6061-T6, 32,000 PSI tensile yield strength minimum.
 - 1. ASTM B209 for sheets and plates.
 - 2. ASTM B221 and ASTM B308 for shapes: Beams, channels, angles, tees and zeeks.
 - 3. ASTM B247 for forgings.
- B. Alloy 6063-T5 or T6.
 - 1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
- C. Nonferrous Bolts and Nuts: ASTM F467 and ASTM F468 of alloy 2024-T4 (60,000 PSI tensile strength minimum).
- D. Stainless Steel Bolts and Nuts : ASTM F593 and ASTM F594, Type 304 or 316 with a minimum yield strength of 30,000 PSI and a minimum tensile strength of 75,000 PSI.
- E. Washers: Same material and alloy as found in bolts and nuts with which the washers are to be used.
- F. Electrodes for Welding Aluminum: AWS D1.2 filler alloy 5356.
- G. Mechanical and Adhesive Anchor Bolts for Fastening to Concrete:
 - 1. Where approved by Engineer.
 - 2. Stainless steel, Type 304 or 316.
 - 3. See Specification Section 05 50 00, 03 15 19.

2.3 DESIGN

- A. All design shall consider effect of welds on material properties.
 - 1. Eliminate the use of field welding.
 - 2. Observe locations of any specified shop splice welds.

- B. Where final design of connections for any portion of structure is not indicated, perform final design of such connections in accordance with the building code.
- C. Final designs of connections shall conform to AA ADM 1 and to details and requirements stated in the Contract Documents.
 - 1. Design loads for connections to be designed by the Contractor shall be as shown on the Drawings.
 - 2. Where design loads are not specified, connections shall be detailed to develop the full capacity of the member.

2.4 FABRICATION

- A. Fabrication of bolted and welded connections of aluminum work shall be in accordance with AA ADM 1.
- B. Contractor to be solely responsible for correctness of all shop and field fabrication and fit. Verify field conditions and dimensions prior to fabrication.
- C. Fabricate aluminum work and assemble in shop to greatest extent possible.
 - 1. Make splices only where indicated or approved by Engineer.
- D. Provide connections as indicated.
 - 1. Where not indicated, design and provide connections in accordance with requirements of this Specification Section.
 - 2. One-sided or other types of eccentric connections are not acceptable unless indicated on Contract Drawings or approved on Shop Drawings.
- E. Drill or punch holes at right angles to surface of metal.
 - 1. Do not make or enlarge holes by burning.
 - 2. Provide holes clean and free of torn or ragged edges.
 - 3. Use tools which will make a 1/16 IN bevel to remove outside burrs resulting from drilling or punching operations.
 - 4. Punch or drill for field connections and for attachment of work by other trades.
- F. Cope at 45 DEG corners of stiffener plates at junction of member flanges with webs.
- G. Welding:
 - 1. Weld connections to members in shop and bolt connections in field.
 - 2. Perform welding using electrodes of filler alloy 5356.
 - 3. Perform welding in accordance with AWS D1.2.
 - 4. Use only welding procedures and welding operators qualified in accordance with requirements of Paragraph 1.2B. Qualifications.
- H. All full penetration welds shall be nondestructively tested by liquid penetrant or ultrasonic methods per AWS standards.
- I. Form to shapes indicated with straight lines, true angles and smooth curves.
 - 1. Grind smooth all rough welds and sharp edges.
 - 2. Round all corners to approximately 1/8 IN radius.
- J. Finish: Mill finish as fabricated.
 - 1. Architectural Class 1 coating per AA DAF 45:
 - a. Black AA-M12C22A42.

2.5 SOURCE QUALITY CONTROL

- A. Special Inspection and Testing:
 - 1. Contractor responsible for testing to qualify shop welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
 - 2. Contractor to inspect and test fabrication in accordance with the fabricators quality control procedures and in accordance with ADM-1 2015 or later.

3. Contractor inspect shop welding in accordance with AWS D1.2, Section 5 including the following non-destructive testing:
 - a. Visually inspect all welds.
 - b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant.
 - c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.

PART 3 - EXECUTION

3.1 ERECTION

- A. Contractor is solely responsible for safety.
 1. Construction means and methods and sequencing of work is prerogative of the Contractor.
 2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until decks and diagonal bracing or rigid moment connections are installed.
 3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
 4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor.
- B. Bolting:
 1. Protect bolt threads from damage.
 2. Rest bolt heads and nuts squarely against surfaces.
 3. Where bolt heads or nuts rest on beveled surfaces having slope greater than 1 IN 20 with plane normal to bolt axis, use beveled washers to provide full bearing to head and nut.
 4. Correct poor matching of holes by drilling to next larger size and use larger diameter bolt.
 5. Unless otherwise specified, connect aluminum members to:
 - a. Aluminum members using 3/4 IN DIA nonferrous bolts of alloy 2024-T4 or stainless steel bolts (ASTM F593 and ASTM F594).
 - b. Carbon and low alloy steel using 3/4 IN DIA stainless steel bolts (ASTM F593 and ASTM F594).
 - 1) Provide dissimilar materials protection.
 - c. Concrete or masonry using stainless steel expansion anchor bolts or adhesive anchor bolts unless shown otherwise.
 - 1) Provide dissimilar materials protection.
- C. Welding: Field welding of aluminum is not allowed unless indicated on Drawings.
- D. Correct fabrication errors and damaged members in shop.
 1. Do not use cutting torch in shop or in field to cut any members, to correct fabrication errors, or to cut openings.
- E. Provide templates for anchors, bolts, and other items to be installed in other work.
- F. Field Assembly:
 1. Tolerances shall comply with AISC 325 and the ADM-1.
 - a. Before members are assembled, thoroughly clean all bearing surfaces and surfaces that will be in permanent contact.
 - b. After assembly, carefully align all members of each frame or assembly and accurately adjust until final, correct and true location is achieved.
 - 1) As work progresses, securely fasten in place.
 2. Provide full length members without splices.
 3. Securely tighten and leave in place all erection bolts used in welded construction, unless removal is required.

- G. Set beam and column baseplates accurately, as indicated on nonshrink grout, in accordance with Division 03.
 - 1. If not indicated, provide minimum of 1 IN grout thickness under base plates.
 - 2. Set and anchor each base plate to proper line and elevation.
 - a. Use aluminum wedges, shims, or setting nuts for leveling and plumbing columns and beams.
 - 1) Tighten anchor bolts.
 - b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
 - 1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
 - c. Do not remove wedges or shims and where they protrude, cut off flush with edge of base plate.
- H. Temporary Protection:
 - 1. Suitably protect aluminum surfaces against lime mortar stains, discoloration, surface abrasion and other construction abuses.
 - 2. Remove protection.
- I. Contact with Dissimilar Materials: Where aluminum surfaces will be embedded in concrete, built into masonry, or in contact with steel, concrete, grout, masonry, or other dissimilar materials, coat the aluminum surfaces as described in Specification Section 09 96 00.

3.2 FIELD QUALITY CONTROL

- A. Special Inspection and Testing:
 - 1. See Section 01 45 23.
 - 2. Special Inspection is required to:
 - a. Inspect structural aluminum delivered on site, prior to erection.
 - 1) Visually inspect all welds, bolts and general fabrication
 - b. Verify proper identification markings for bolts, nuts and washers per applicable standards. Verify proper hole and bolt size.
 - 1) Frequency: All bolts, prior to being covered up or substantial completion.
 - c. Inspect structural aluminum which has been erected.
 - 1) Inspect the following:
 - a) Details such as bracing and stiffening.
 - b) Member locations.
 - c) Erection tolerances.
 - d) Application of joint details at each connection.
 - 2) Frequency: Prior to members being covered up or substantially complete.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
 2. Design of all temporary bracing not indicated on Drawings.
 3. Design of systems and components, including but not limited to:
 - a. Screen Assembly:
 - b. Stairs.
 - c. Landings.
 - d. Ladders.
 - e. Modular framing system.
- B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
 2. Division 01 - General Requirements.
 3. Section 03 05 05 - Concrete.
 4. Section 03 15 19 - Anchorage to Concrete.
 5. Section 03 31 30 - Concrete, Materials and Proportioning.
 6. Section 05 12 00 - Structural Steel.
 7. Section 05 14 00 - Structural Aluminum.
 8. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
1. Aluminum Association (AA):
 - a. ADM 1, Aluminum Design Manual.
 2. American Association of State Highway and Transportation Officials (AASHTO):
 - a. HB, Standard Specifications for Highway Bridges.
 3. American Institute of Steel Construction (AISC):
 - a. 325, Manual of Steel Construction.
 - b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
 4. The American Ladder Institute (ALI):
 - a. A14.3, Ladders - Fixed - Safety Requirements.
 5. American Society of Civil Engineers (ASCE):
 - a. 7, Minimum Design Loads for Buildings and Other Structures.
 6. ASTM International (ASTM):
 - a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - b. A36, Standard Specification for Carbon Structural Steel.
 - c. A47, Standard Specification for Ferritic Malleable Iron Castings.
 - d. A48, Standard Specification for Gray Iron Castings.
 - e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
 - g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

- h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- i. A197, Standard Specification for Cupola Malleable Iron.
- j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- k. A276, Standard Specification for Stainless Steel Bars and Shapes.
- l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
- o. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- q. A536, Standard Specification for Ductile Iron Castings.
- r. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
- s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
- w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- x. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- y. A992, Standard Specification for Steel for Structural Shapes.
- z. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- aa. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.
- cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- dd. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- ee. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- ff. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- gg. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- hh. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
- ii. F467, Standard Specification for Nonferrous Nuts for General Use.
- jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
- kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ll. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.
- mm. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
- nn. F1789, Standard Terminology for F16 Mechanical Fasteners.
- oo. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. American Welding Society (AWS):
 - a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
 - b. D1.1, Structural Welding Code - Steel.
 - c. D1.2, Structural Welding Code - Aluminum.
 - d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
 8. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. AMP 510, Metal Stairs Manual.
 - b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
 - c. MBG 531, Metal Bar Grating Manual.
 9. NACE International (NACE).
 10. Nickel Development Institute (NiDI):
 - a. Publication 11 007, Guidelines for the welded fabrication of nickel-containing stainless steels for corrosion resistant services.
 11. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
- B. Qualifications:
1. Qualify welding procedures and welding operators in accordance with AWS.
 2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
 3. Engineer for contractor-designed systems and components: Professional engineer licensed in the State of WA.
 4. NACE certified inspector shall have minimum of two years of experience performing inspections as indicated.
 - a. Have a current Level III coating inspector certification.

1.3 DEFINITIONS

- A. Fasteners: As defined in ASTM F1789.
- B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
- C. Hardware: As defined in ASTM A153/A153M.
- D. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Qualifications:
 - a. NACE inspector qualifications.
 3. Fabrication and/or layout drawings and details:
 - a. Submit drawings for all fabrications and assemblies.
 - 1) Include erection drawings, plans, sections, details and connection details.
 - b. Identify materials of construction, shop coatings and third party accessories.
 4. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.

- c. Provide manufacturer's standard allowable load tables for the following:
 - 1) Grating and checkered plate.
 - 2) Castings, trench covers and accessories.
 - 3) Modular framing systems.
 - 5. Contractor designed systems and components:
 - a. Certification that manufactured units meet all design loads specified.
 - b. Shop Drawings and engineering design calculations:
 - 1) Indicate design live loads.
 - 2) Sealed by a licensed professional engineer, registered in the State of WA.
 - 3) Engineer will review for general compliance with Contract Documents.
 - c. Contractor designed systems and components include the following:
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Certification of welders and welding processes.
 - a. Indicate compliance with AWS.
 - 3. NACE certification of surface preparation.
 - 4. NACE certification of paint application.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and handle fabrications to avoid damage.
- B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Screen Assembly:
 - a. Hendrick Screen, 270.685.5138, www.hendrickscreenco.com .
 - 2. Abrasive stair nosings (embedded in concrete stairs):
 - a. American Safety Tread.
 - b. Balco.
 - 3. Headed studs and deformed bar anchors:
 - a. Nelson Stud Welding Div., TRW Inc.
 - b. Stud Welding Products, Inc.
 - 4. Mechanical anchor bolts:
 - a. See Section 03 15 19.
 - 5. Epoxy adhesive anchor bolts:
 - a. See Section 03 15 19.
 - 6. Concrete screw anchors:
 - a. See Section 03 15 19.
 - 7. Castings, trench covers and accessories:
 - a. Neenah Foundry Co.
 - b. Deeter Foundry Co.
 - c. Barry Craft Construction Casting Co.
 - d. McKinley Iron Works.
 - 8. Aluminum ladders:
 - a. Any manufacturer capable of meeting the requirements of this Specification Section.
 - 9. Galvanizing repair paint:
 - a. Clearco Products Co., Inc.
 - b. ZRC Products.
 - 10. Modular framing system:

- a. Unistrut Building Systems.
 - b. B-Line Systems.
 - c. Kindorf.
 - d. Superstrut.
11. Ladder safety extension post:
- a. Bilco.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Steel:

- 1. Structural:
 - a. W-shapes and WT-shapes: ASTM A992, Grade 50.
 - b. All other plates and rolled sections: ASTM A36.
- 2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
- 3. Structural tubing:
 - a. ASTM A500, Grade B (46 KSI minimum yield).
- 4. Bolts, high strength:
 - a. ASTM F3125, Grade A325.
- 5. Nuts, high strength:
 - a. ASTM A563.
- 6. Washers (hardened):
 - a. ASTM F436.
 - b. Provide two (2) washers with all bolts.
- 7. Bolts and nuts (unfinished):
 - a. ASTM A307, Grade A.
- 8. Welding electrodes: AWS D1.1, E70 Series.
- 9. Steel forgings: ASTM A668.

B. Iron:

- 1. Ductile iron: ASTM A536.
- 2. Gray cast iron: ASTM A48 (minimum 30,000 PSI tensile strength).
- 3. Malleable iron: ASTM A47, ASTM A197.

C. Stainless Steel:

- 1. Stainless steel in welded applications: Low carbon 'L' type.
- 2. Minimum yield strength of 30,000 PSI and minimum tensile strength of 75,000 PSI.
 - a. Bars, shapes: ASTM A276, Type 304.
 - b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
 - c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
 - d. Bolts and nuts: ASTM F593, Type 304 or 316.
- 3. Minimum yield strength of 25,000 PSI and minimum tensile strength of 70,000 PSI.
 - a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
- 4. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Aluminum:

- 1. Alloy 6061-T6, 32,000 PSI tensile yield strength minimum.
 - a. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, tees and zees.
 - b. Weir plates, baffles and deflector plates, ASTM B209.
- 2. Alloy 6063-T5 or T6, 15,000 PSI tensile yield strength minimum.
 - a. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
- 3. ASTM B26 for castings.
- 4. ASTM F468, alloy 2024 T4 for bolts.
- 5. ASTM F467, alloy 2024 T4 for nuts.
- 6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.

E. Washers: Same material and alloy as found in accompanying bolts and nuts.

- F. Embedded Anchor Bolts:
 - 1. See Specification Section 03 15 19.
- G. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
 - 1. See Specification Section 03 15 19.
- H. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.
- I. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.
- J. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.
- K. Galvanizing Repair Paint:
 - 1. High zinc dust content paint for regalvanizing welds and abrasions.
 - 2. ASTM A780.
 - 3. Zinc content: Minimum 92 PCT in dry film.
 - 4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."
- L. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.3 MANUFACTURED UNITS

- A. Screen Assembly:
 - 1. Material:
 - a. All metal work shall be Stainless Steel 304L.
 - 2. The Screen shall be Profile Bar B6.
 - a. Spacing:
 - 1) Maximum clear distance between Profile bars to be 1.75mm.
 - 2) The effective open area of the screen material must be at greater than 27%.
 - 3. Screen support:
 - 4. Screen support shall be designed by the screen fabricator for a minimum 40 pound per square foot uniform load over the entire screen area.
- B. Ladders:
 - 1. General:
 - a. Fully welded type.
 - 1) All welds to be full penetration welds, unless otherwise specified.
 - b. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings.
 - c. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and the building code.
 - d. Ladders shall be designed to support a minimum concentrated live load of 300 LBS at any point to produce the maximum stress in the member being designed.
 - 1) Apply additional 300 LB loads for each section of ladder exceeding 10 FT.
 - e. Maximum allowable stresses per AA ADM 1.
 - f. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
 - 2. Material:
 - a. Aluminum.
 - b. Finish:
 - 1) Mill.
 - 3. Rails:
 - a. Round pipe or rectangular tubing:
 - 1) Round pipe:
 - a) 1-1/2 IN nominal diameter.
 - b) Schedule 80.
 - 2) Rectangular tubing:

- a) Cross-section: 3 by 2 IN maximum.
 - b) Thickness: 0.125 IN minimum.
 - b. Spacing:
 - 1) Minimum clear distance between rails to be 18 IN.
 - 2) Step-through ladder extensions: 24 IN, centerline to centerline.
 - c. Provide cap at exposed top and bottom of side rails.
 - 1) Provide weep holes as necessary to prevent the accumulation of moisture within hollow members.
 - d. Extend side rails of step-through ladders a minimum of 42 IN above the landing.
- 4. Rungs:
 - a. Minimum 1 IN DIA or 1 IN square solid bar.
 - 1) Integral non-slip finish on all sides.
 - a) Non-slip finish: Coarse knurling or extruded serrations.
 - b) Shop or field-applied grit tape and cap type non-slip finishes are not acceptable.
 - b. Rungs shall penetrate inside wall of side rails.
 - 1) Do not extend rungs beyond the outside face of the side rail.
 - 2) Provide fillet weld all around rung at inside face of side rail and plug weld at outside face of side rail.
 - c. Rung spacing:
 - 1) Equally spaced not less than 10 IN and not more than 14 IN as measured between the centerlines of the rungs.
 - a) Ladder rungs and steps in elevator shafts shall be spaced not less than 6 IN and not more than 16.5 IN as measured between the centerlines of the rungs.
 - 2) Top rung shall be level with landing or platform.
 - a) Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 IN below, adjacent walking surface.
- 5. Brackets:
 - a. Angle or bent plate brackets welded to side rails:
 - 1) 3/8 IN by 2-1/2 IN by length required.
 - 2) Provide punched holes for 3/4 IN bolts or anchors.
 - 3) Minimum distance from centerline of rung to wall or any obstruction: 7 IN.
 - 4) Maximum spacing: 4 FT OC.
 - b. For floor supported ladders, provide 3/8 by 2-1/2 by 4 IN rectangular bracket or 3/8 by 6 by 6 IN square plate welded to rails with punched holes for 3/4 IN bolts.
 - 1) Provide wall brackets on floor supported units if vertical run is over 4 FT.
- 6. Landings:
 - a. Construct landing, railing and all supports of same material as the ladder.
 - b. Design live load for landing platform and supporting structure:
 - 1) 100 PSF, uniform load.
 - 2) 300 LBS concentrated load on 4 IN square area.
 - 3) All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
 - 4) Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
 - c. Grating:
 - 1) Per this Specification Section.
 - d. Structural support: Channel or tubular sections with bracing, plates, angles, etc., to support guardrail and grating and to support landing from the side of the structure .
 - 1) Weld or bolt all connections using stainless steel with aluminum and stainless steel members and galvanized with non aluminum and stainless steel (bolts, nuts and washers).
 - e. Guardrails:
 - 1) Match ladder side rails.
 - a) Space intermediate rails equally between top rail and top of kickplate.
 - 2) Provide 4 IN high x 3/8 IN thick toeboard each side of landing.

7. Gates:
 - a. Constructed of same material and sizes as the railing system.
 - b. Hinges:
 - 1) Stainless steel.
 - 2) Heavy-duty, self-closing.
 - c. Gate stop:
 - 1) Match railing material Aluminum, Galvanized steel, Stainless steel.
 8. Ladder safety extension post:
 - a. Telescoping tubular aluminum, galvanized steel or stainless steel section that automatically locks into place when fully extended.
 - b. Non-ferrous corrosion-resistant spring and hardware.
 - c. Factory assembled with all hardware necessary for mounting to ladder.
 - d. Bilco "LadderUp" safety post.
 9. Deflector plate:
 - a. For aluminum ladders: Minimum 0.0625 IN aluminum plate, ASTM B209.
 - b. For stainless steel ladders: Minimum 0.0625 IN stainless steel plate, ASTM A666.
 - c. For steel ladders: Minimum 0.0625 IN steel plate, ASTM A6.
 - d. Profile as shown on Drawings.
 - e. Fabricate to shapes and sizes required to meet OSHA Standards.
- C. Bollards:
1. 8 IN DIA extra strength steel pipe, ASTM A53.
 - a. Galvanized.
 - b. See Specification Section 09 96 00 for painting requirements.
- D. Abrasive Stair Nosings:
1. Exterior cast-in-place concrete stairs:
 - a. One piece cast aluminum with wing anchors.
 - b. Diamond abrasive pattern.
 - c. Babcock Davis "BSTCA-C3W".
 2. Interior stairs:
 - a. Two component consisting of an embedded subchannel and an abrasive tread plate .
 - b. Subchannel: 6063-T5 extruded aluminum.
 - 1) Complete with concrete anchors.
 - c. Tread plate:
 - 1) 6063-T5 extruded aluminum.
 - 2) Solid epoxy abrasive filler.
 - a) Color: To be selected by Owner.
 - d. Balco "DXH-330", "DXH-330-PL-100".
 - e. Finish: Mill.
 3. Length:
 - a. Concrete stairs and landings:
 - 1) 4 IN less than overall stair width.
 - 2) Where tread mounted railing post occurs, hold nosing back 4 IN clear from railing centerline.
 - b. Concrete filled metal pan stairs: Full length of tread.
 - c. Concrete landings at metal stairs: 4 IN less than clear width between stringers.
- E. Metal Stairs:
1. Treads: Grating as specified.
 - a. Provide integral corrugated non-slip nosing.
 2. Risers:
 - a. Grating treads:
 - 1) Solid plate welded to trailing edge of tread or landing.
 - 2) Minimum 3/16 IN thick by 4 IN high.
 - b. Checkered plate treads: Solid checkered plate riser integral with tread.
 3. Landings:

- a. Grating as specified.
 - b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.
 - 4. Design live load for landing platform and supporting structure:
 - a. 100 PSF, uniform load.
 - b. 300 LBS concentrated load [on 4 IN square area].
 - c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
 - d. Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
 - 5. Design, fabricate, and install in compliance with NAAMM and applicable codes.
 - a. NAAMM AMP 510:
 - 1) Exterior at site structures and equipment: Industrial Class.
 - 2) Interior or exterior at buildings: Service Class.
 - 6. Handrails and guardrails: Refer to Specification Section 05 52 02.
 - 7. Material:
 - a. Steel: ASTM A36, galvanized after fabrication.
- F. Stairs, Concrete Filled Steel Pan:
- 1. Fabricated as indicated.
 - a. ASTM A36 steel.
 - 2. Treads: Minimum 14 GA pans with self-furring metal lath welded in pan.
 - 3. Risers: Minimum 14 GA.
 - 4. Landings: minimum 10 GA pans with angle supports as required to support loading indicated and concrete.
 - a. Provide self-furring metal lath reinforcing welded in the pan.
 - 5. Design live load for landing platform and supporting structure:
 - a. 100 PSF, uniform load.
 - b. 300 LBS concentrated load on 4 IN square area.
 - c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
 - d. Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
 - 6. Design, fabricate, and install in compliance with NAAMM and applicable codes.
 - a. NAAMM AMP 510: Commercial Class.
 - b. ICC A117.1.
 - 7. Nosings:
 - a. Abrasive nosings as specified.
 - b. Coordinate riser height to compensate for thickness of nosing.
 - 8. Handrails and guardrails: Refer to Specification Section 05 52 02.
 - 9. Galvanize entire assembly after fabrication.
- G. Steel Checkered Plate:
- 1. Provide galvanized checkered plate and edge supports.
 - 2. Conform to ASTM A786.
 - a. Diamond pattern: No.3 (large) or No.4 (medium).
 - b. Use one pattern throughout Project.
 - c. Material: 36 KSI minimum yield strength.
 - 3. Design live load (unless noted otherwise on Drawings):
 - a. 100 PSF, uniform load.
 - b. 300 LBS concentrated load on 4 IN square area.
 - c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
 - d. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.
 - 4. Reinforce as necessary with steel angles welded to underside of checkered plate.
 - 5. Plate sections:
 - a. Maximum 3 FT wide.
 - b. Minimum 1/4 IN thick.
 - c. Maximum 100 LBS per section if required to be removable.

6. Provide joints at center of all openings unless shown otherwise.
 - a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
 7. Unless shown otherwise, frame for opening with steel checkered plate cover:
 - a. Steel support angles:
 - 1) 3 by 2 by 1/4 IN minimum size with long leg vertical.
 - 2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two anchor bolts per side.
 - b. Steel concrete insert seats:
 - 1) 2 by 2 by 1/4 IN minimum size.
 - 2) Auto-welded studs or strap anchors, ASTM A108 at 18 IN OC with not less than two studs or anchors per side.
 - c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two fasteners per side.
 - 1) Fasteners: Flat countersunk cap screws, ASTM F835.
 - a) Galvanized, ASTM A153/A153M.
- H. Aluminum Checkered Plate:
1. Conform to ASTM B632.
 - a. Diamond pattern: Use one pattern throughout Project.
 - b. Material: Type 6061-T6.
 2. Design live load:
 - a. 100 PSF, uniform load.
 - b. 300 LBS concentrated load on 4 IN square area.
 - c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
 - d. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.
 3. Reinforce as necessary with aluminum angles.
 4. Plate sections:
 - a. Maximum 3 FT wide.
 - b. Minimum 1/4 IN thick.
 - c. Maximum 100 LBS per section if required to be removable.
 5. Provide joints at center of all openings unless shown otherwise.
 - a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
 6. Unless shown otherwise, frame for openings with aluminum checkered plate cover:
 - a. Aluminum support angles:
 - 1) 3 by 2 by 1/4 IN minimum size with long leg vertical.
 - 2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two anchor bolts per side.
 - b. Aluminum concrete insert seats:
 - 1) 2 by 2 by 1/4 IN minimum size.
 - 2) Auto-welded studs or strap anchors at 18 IN OC with not less than two studs or anchored per side.
 - c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two fasteners per side.
 - 1) Fasteners: Stainless steel flat countersunk cap screws: ASTM F879.
- I. Aluminum Grating:
1. NAAMM MBG 531.
 2. Bearing bars: Rectangular, 1-1/2 by 3/16 IN at 1-3/16 IN OC spacing OR I-bar, 1-1/2 IN deep with minimum 1/16 IN thick bar and minimum 1/4 IN flange width at 1-3/16 IN OC spacing (unless noted otherwise on Drawings).
 3. Cross bars:
 - a. Welded, swaged or pressure locked to bearing bars:
 - b. Maximum 4 IN/OC spacing.

4. Top edges of bars: Grooved or serrated.
 5. Finish: Mill, standard.
 6. Clips and bolts: Stainless steel.
 7. Seat angles: Aluminum or stainless steel
- J. Steel Grating:
1. NAAMM MBG 531.
 2. Bearing bars:
 - a. Rectangular 1-1/2 by 3/16 IN unless otherwise noted on Drawings.
 - b. Maximum 1-3/16 IN OC spacing.
 3. Cross bars:
 - a. Welded, swagged or pressure locked to bearing bars.
 - b. Maximum 4 IN OC spacing.
 4. Top edges of bars: Serrated or grooved.
 5. Removable grating sections: Not wider than 3 FT and not more than 100 LBS.
 6. Finish:
 - a. Galvanized.
 - b. Clips and bolts: Galvanized.
 - c. Seat angles: Galvanized steel.
 7. Ends and perimeter edges: Banded.
 8. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
 9. Provide joints at openings between individual grating sections.
- K. Heavy-Duty Castings, Trench Covers, and Accessories:
1. Prefabricated, cast iron ASTM A48.
 2. Design load: AASHTO HS-20 wheel loading for indicated span.
 3. Machine horizontal mating surfaces.
- L. Access Cover:
1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
 2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
 3. Equip lid with four stainless steel screws to secure lid to frame.
- M. Loose Lintels:
1. Steel, ASTM A36 or ASTM A572 Grade 50, sizes as indicated on Drawings.
 2. Hot-dip galvanized per ASTM A123/A123M.
- N. Modular Framing System:
1. Materials:
 - a. Steel: ASTM A1011, stainless steel, Grade 33.
 - 1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
 - b. Aluminum: ASTM B221 or ASTM B209.
 - c. Stainless steel: ASTM A666.
 2. Channels and inserts:
 - a. Steel or stainless steel: Minimum 12 GA.
 - b. Aluminum: Minimum 0.080 IN.
 - c. Channels to have one side with a continuous slot with in-turned lips.
 - 1) Width: 1-5/8 IN.
 - 2) Depth and configuration as necessary for loading conditions.
 3. Fittings: Same material as system major components.
 4. Fasteners:
 - a. Nuts: Toothed grooves in top of nuts to engage the in-turned lips of channel.
 - b. Bolts: Hex-head cap screws.
 - c. Same material as system major components.
 5. End caps:

- a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 FT or less above the floor or platform.
 - a) Plastic for all exposed ends 7 FT or more above floor or platform.
 - b) Plastic or metallic for all other exposed ends.
- 6. Schedule:
 - a. Interior wet areas: Stainless steel.
 - 1) Including the following rooms or areas:
 - a) Incubation Room.
 - b. Exterior areas: Fisheries Equipment, piping if metal shall be either Aluminum or Stainless steel including process piping where metal, metal picket panels, gates, screens, but not limited to. Contractor verify material type during bidding and prior to procurement.
 - c. All other areas not listed above: Hot-dipped galvanized steel.
- 7. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.
- 8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

2.4 FABRICATION

- A. Verify field conditions and dimensions prior to fabrication.
- B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
 - 1. Grind smooth all rough welds and sharp edges.
 - a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.
 - b. All fish holding vessels, picket panels or any metal surface that comes into contact with fish shall be smooth to the touch.
- C. Provide drilled or punched holes with smooth edges.
 - 1. Punch or drill for field connections and for attachment of work by other trades.
- D. Weld Shop Connections:
 - 1. Welds to be continuous fillet type unless indicated otherwise.
 - 2. Full penetration butt weld at bends in stair stringers and ladder side rails.
 - 3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
 - 4. Weld aluminum in accordance with AWS D1.2.
 - 5. Weld stainless steel in accordance with AWS D1.6 .
 - a. Treat all welded areas in accordance with ASTM A380.
 - 6. All headed studs to be welded using automatically timed stud welding equipment.
 - 7. Grind smooth welds that will be exposed.
- E. Passivate stainless steel items and stainless steel welds after they have been ground smooth.
 - 1. ASTM A380.
- F. Conceal fastenings where practicable.
- G. Fabricate work in shop in as large assemblies as is practicable.
- H. Tolerances:
 - 1. Rolling:
 - a. ASTM A6.
 - b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
 - 2. Fabrication tolerance:
 - a. Member length:
 - 1) Both ends finished for contact bearing: 1/32 IN.
 - 2) Framed members:
 - a) 30 FT or less: 1/16 IN.

- b) Over 30 FT: 1/8 IN.
 - b. Member straightness:
 - 1) Compression members: 1/1000 of axial length between points laterally supported.
 - 2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
 - c. Specified member camber (except compression members):
 - 1) 50 FT or less: -0/+1/2 IN.
 - 2) Over 50 FT: -0/+1/2 IN (+1/8 IN per 10 FT over 50 FT).
 - 3) Members received from mill with 75 PCT of specified camber require no further cambering.
 - 4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
 - 5) Camber shall be measured in fabrication shop in unstressed condition.
 - d. At bolted splices, depth deviation shall be taken up by filler plates.
 - 1) At welded joints, adjust weld profile to conform to variation in depth.
 - 2) Slope weld surface per AWS requirements.
 - e. Finished members shall be free from twists, bends and open joints.
 - 1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.
- I. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum galvanized steel unless shown otherwise on Drawings.
 - 1. Finish:
 - a. Mill, unless noted otherwise.
 - b. Coat surfaces in contact with dissimilar materials.
 - 1) See Specification Section 09 96 00.
- J. Fabricate grating in accordance with NAAMM MBG 531.
 - 1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 IN.
 - 2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 IN.
 - a. Tolerance: NAAMM MBG 531.
 - 3. Removable sections: Not wider than 3 FT and not heavier than 100 LBS.
 - 4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
 - a. Provide full depth banding unless noted otherwise.
 - b. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage.
 - 5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
 - 6. Provide joints at openings between individual grating sections.
 - 7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.
- K. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
 - 1. Workmanship: Class 2 unless noted otherwise.
- L. See Specification Section 09 96 00 for preparation and painting of ferrous metals and other surfaces.

2.5 SOURCE QUALITY CONTROL

- A. Surface Preparation:
 - 1. Refer to Specification Section 09 96 00 for surface preparation requirements.
 - 2. All miscellaneous metal fabrication item surfaces shall be inspected and approved by NACE certified coatings inspector prior to application of shop-applied coatings.
 - a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
 - b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.
- B. Shop Applied Coating Application:

1. Refer to Specification Section 09 96 00 for coating requirements.
 2. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of coatings.
 3. Application of coatings shall be observed and certified by NACE certified coatings inspector.
- C. Shop Inspection and Testing:
1. Owner will employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
 2. Contractor responsible for testing to qualify shop and field welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
 3. Independent testing agency shall have a minimum of five years performing similar work and shall be subject to Owner's approval.
- D. Responsibilities of Testing Agency:
1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
 - a. Visually inspect all welds.
 - b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant or mag particle.
 - c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
 2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
 - a. Verify direct tension indicator gaps, if applicable.
 3. Inspect structural steel which has been erected.
 4. Inspect stud welding in accordance with AWS Code.
 5. Prepare and submit inspection and test reports to Engineer.
 - a. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide items to be built into other construction in time to allow their installation.
1. If such items are not provided in time for installation, cut in and install.
- B. Prior to installation, inspect and verify condition of substrate.
- C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

- A. Set metal work level, true to line, plumb.
1. Shim and grout as necessary.
- B. Contractor is solely responsible for safety.
1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
 2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
 3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
 4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

- C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
 - 1. Plumb, align, and set structural steel members to specified tolerances.
 - 2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
 - 3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
 - 4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
 - a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
 - 5. Remove and dispose of all temporary work and facilities off-site.
- D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
 - 1. Report defects in work-in-place which may influence satisfactory completion of the work.
 - 2. Absence of such notification will be construed as acceptance of work-in-place.
- E. Field Measurement:
 - 1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
 - 2. Contractor responsible for the accurate fit of the work.
- F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
 - 1. Use surveyor's level.
 - 2. Notify Engineer of any errors or deviations found by such checking.
- G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
- H. Erect plumb and level; introduce temporary bracing required to support erection loads.
- I. Use light drifting necessary to draw holes together.
 - 1. Drifting to match unfair holes is not allowed.
- J. Welding:
 - 1. Conform to AWS D1.1 and requirements of the FABRICATION Article in PART 2 of this Specification Section.
 - 2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.
- K. Shore existing members when unbolting of common connections is required.
 - 1. Use new bolts for rebolting connections.
- L. Clean stored material of all foreign matter accumulated prior to the completion of erection.
- M. Bolt Field Connections: Where practicable, conceal fastenings.
- N. Field Welding:
 - 1. Follow AWS procedures.
 - 2. Grind welds smooth where field welding is required.
- O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
 - 1. Replace entire section.

- P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.
- Q. Unless noted or specified otherwise:
1. Connect steel members to steel members with 3/4 IN DIA ASTM F3125, Grade A325 high strength bolts.
 2. Connect aluminum to aluminum with 3/4 IN DIA stainless bolts.
 3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts.
 - a. Provide dissimilar metals protection.
 4. Connect aluminum and steel members to concrete and masonry using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
 - a. Provide dissimilar materials protection.
 5. Provide washers for all bolted connections.
 6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top of installed nut.
 - a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.
- R. Install and tighten ASTM F3125, Grade A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
1. Provide hardened washers for all Grade A325 bolts.
 - a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.
- S. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.
- T. Secure metal to wood with lag screws of adequate size with appropriate washers.
- U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
1. Provide full penetration welded splices where continuity is required.
- V. Provide each fabricated item complete with attachment devices as indicated or required to install.
- W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.
- X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
1. See Division 03 Specification Sections for non-shrink grout and anchorage.
 2. Set and anchor each base plate to proper line and elevation.
 - a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
 - 1) Wedges, shims and setting nuts to be of same metal as base plate they support.
 - 2) Tighten nuts on anchor bolts.
 - b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
 - 1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
 - c. Do not remove wedges or shims.
 - 1) Where they protrude, cut off flush with edge of base plate.
 - d. Fill sleeves around anchor bolts solid with non-shrink grout.
- Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
1. Tack welding prohibited.
 - a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
 2. Anchor bolt location tolerance:
 - a. Per Section 03 15 19.
- Z. Install bollards as detailed on Drawings.
1. Fill pipe with concrete and round off at top.

- AA. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
1. Center stair nosings in stair width.
- BB. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
1. Keep screw holes clean and ready to receive screws.
- CC. Attach grating to end and intermediate supports with grating saddle clips and bolts.
1. Maximum spacing: 2 FT OC with minimum of two per side.
 2. Attach individual units of aluminum grating together with clips at 2 FT OC maximum with a minimum of two clips per side.
- DD. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.
- EE. Repair damaged galvanized surfaces in accordance with ASTM A780.
1. Prepare damaged surfaces by abrasive blasting or power sanding.
 2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.
- FF. Anchor ladder to concrete structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.
- GG. Anchor ladder to masonry structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.
1. When anchoring into masonry, fill masonry cores with grout at anchor locations and each masonry core within 8 IN of anchor
 2. When anchoring into cavity wall construction, provide minimum 6 IN embedment into concrete or masonry back-up wall.
 - a. At each anchor location, provide sleeve between back face of veneer and cavity face of concrete or masonry back-up wall.
 - b. Cut cavity insulation as required and seal around sleeve.
 - 1) Sleeve to be 1 IN DIA schedule 40 stainless steel tubing, TP-304L, ASTM A269.
 - a) Minimum wall thickness to be .065 IN.
 - 2) Continuously weld 4 by 4 by 1/4 IN Type 304 stainless steel, ASTM A666 flange onto each end of pipe.
 - a) Drill 1 IN hole in flange to match pipe.
 - b) Attach sleeve to concrete or masonry back-up with 1/4 IN concrete screw anchors.
 - 3) Grout solid, area around bolt where bolt penetrates veneer.
 - 4) Accurately locate sleeves to align with bolt locations on ladder.
- HH. Anchor ladder to metal stud walls using minimum 1/2 IN stainless steel bolts, nuts and washers.
1. Verify that stud wall has been provided with adequate backing to accept ladder anchors.
- II. Install ladder safety extension post in accordance with manufacturer's instructions.
1. Mount device opposite the climbing side.
 2. Provide ladder safety extension device for all ladders unless noted otherwise.
- JJ. Mount ladder fall protection system with rail offset from ladder side rail approximately 3 IN.
- KK. Install factory pre-fabricated stairs in location indicated in the Contract Documents and approved submittals.

3.3 FIELD QUALITY CONTROL

- A. Tolerances shall meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature.
- B. Tolerances (unless otherwise noted on the Drawings):
1. Frame placement, after assembly and before welding or tightening.

- a. Deviation from plumb, level and alignment: 1 IN 500, maximum.
- b. Displacement of centerlines of columns: 1/2 IN maximum, each side of centerline location shown on Drawings.
- C. Owner Pays for Field Inspection and Testing:
 - 1. Owner will employ and pay for services of an independent testing agency to inspect and test structural steel shop and field work for compliance with this Specification Section.
 - 2. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
 - 3. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.

3.4 CLEANING

- A. After fabrication, erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.
- B. All stainless steel products in addition to Paragraph A. above:
 - 1. Remove all heat tint, rusting, discoloration by passivation, ASTM A380, or other acceptable means as listed in NiDI 11 007 as approved by the Engineer.
- C. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09 96 00.

END OF SECTION

SECTION 05 52 02
ALUMINUM RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Aluminum handrail, stair rail and guardrail.
 - 2. Aluminum guardrail gates.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 05 50 00 - Metal Fabrications.
 - 2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Aluminum Association (AA):
 - a. ADM 1, Aluminum Design Manual.
 - 2. American Society of Mechanical Engineers (ASME):
 - a. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - 3. ASTM International (ASTM):
 - a. B108, Standard Specification for Aluminum-Alloy Permanent Mold Castings.
 - b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - d. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
 - e. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - f. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - 4. American Welding Society (AWS):
 - a. C5.5, Recommended Practices for Gas Tungsten Arc Welding.
 - b. D1.2, Structural Welding Code - Aluminum.
 - 5. National Association of Architectural Metal Manufacturers (NAAMM):
 - a. AMP 521, Pipe Railing Systems Manual.
 - 6. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
 - a. Americans with Disabilities Act (ADA):
 - 1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - 7. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
- B. Qualifications:
 - 1. Qualify welding procedures and welding operators in accordance with AWS and ASME Section IX.

1.3 DEFINITIONS

- A. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.
- B. Handrail: A horizontal or sloping rail intended for grasping by the hand for guidance or support.

- C. Railing: A generic term referring to guardrail, handrail and/or stair rails.
- D. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Fabrication and/or layout drawings:
 - a. Drawings showing profile, location, sections and fabrication details including all welding information of each railing.
 - b. Type and details of anchorage.
 - c. Location and type of expansion joints.
 - d. Materials of construction, shop coatings and all third-party accessories.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation details.
 - 3. Certification that railings have been designed and fabricated to meet the loading requirements specified.
 - 4. Calculations for all proposed deviations from the Specification.
 - a. Calculations shall be performed, sealed, signed and dated by a registered professional engineer licensed in the State of WA.
 - b. Calculations shall be specific to this Project and shall include all assumptions, references and design interpretations used to achieve the results obtained by the Engineer.
 - c. Reduction in load criteria is not acceptable as reason for deviation from sizes indicated in the Specification.
- B. Informational Submittals:
 - 1. Certification of welders and welding procedures indicating compliance with AWS requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver and handle railings to preclude damage.
- B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Welded railing systems:
 - a. Any manufacturer meeting this Specification Section.

2.2 MATERIALS

- A. Alloy 6061-T6.
 - 1. ASTM B209 for sheets and plates.
 - 2. ASTM B221 and ASTM B308 for shapes - beams, channels, angles, tees, and zeeks.
 - 3. ASTM B247 for forgings.
- B. Alloy 6063-T5 or T6.
 - 1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
- C. Cast Fittings: Aluminum, ASTM B108.
- D. Shims: Aluminum of same alloy as component being shimmed.

- E. Fasteners: See Specification Section 05 50 00.
- F. Expansion and Adhesive Anchors: See Specification Section 03 15 19.
- G. Electrodes for Welding:
 - 1. Aluminum: AWS D1.2.
 - 2. Filler alloy 5356 or 4043.

2.3 FABRICATION

- A. General:
 - 1. Verify field conditions and dimensions prior to fabrication.
 - 2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
 - a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
 - 3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
 - a. Ease exposed edges to a radius of approximately 1/32 IN.
 - b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
 - c. Drill or punch holes with smooth edges.
 - 4. Form exposed connections with flush, smooth, hairline joints, using stainless steel or aluminum splice locks to splice sections together or by welding.
 - a. Ease the edges of top rail splices and expansion joints and remove all burrs left from cutting.
 - 5. Provide for anchorage of type indicated on Drawings or as required by field conditions.
 - a. Drill or punch holes with smooth edges.
 - 6. Design railings and anchorage system in accordance with NAAMM AMP 521 to resist loading as required by the building code.
 - a. Maximum allowable stresses per AA ADM 1.
 - 7. Design railings in accordance with accessibility requirements per the building code and ADAAG.
- B. Custom fabricate railings to dimensions and profiles indicated.
 - 1. Guardrails:
 - a. All Schedule 40 pipe, unless otherwise noted.
 - b. Top rails: 2 IN nominal diameter.
 - c. Intermediate rails: 1-1/2 IN nominal diameter.
 - d. Vertical posts:
 - 1) 2 IN nominal diameter.
 - 2) Vertical posts that are to be side-bracket mounted to a vertical concrete surface or metal structure shall use Alloy 6061-T6 or 6063-T6.
 - 2. Handrail mounted to wall or to guardrail vertical posts: 1-1/4 IN nominal diameter Schedule 40 pipe.
 - 3. Where details are not indicated, space intermediate rails to requirements of the building code or OSHA Standards, whichever requires the more restrictive design.
 - 4. Space vertical posts as required by loading requirements but not more than 4 FT on center.
 - a. Avoid locating vertical posts at changes in direction of railing.
 - b. Hold vertical post back from corner and provide radiused corners.
 - 5. Space handrail brackets as required by loading requirements but not more than 4 FT on center.
 - 6. Base plate for vertical guardrail posts mounted to top of concrete surface:
 - a. 3/8 x 6 x 6 IN square plate.
 - b. Predrilled to accept four anchors.
 - c. Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.
 - d. Fit the vertical post over the solid rod and weld the post to the base plate.
 - 7. Base plate for vertical guardrail post mounted to flange of metal structure:

- a. 3/8 x 3 x 8 IN plate.
 - b. Predrilled to accept two fasteners.
 - c. Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.
 - d. Fit the vertical post over the solid rod and weld the post to the base plate.
 - 8. Mounting bracket for vertical guardrail post mounted to vertical concrete surface or web of metal structural member:
 - a. Pair of 3/8 IN angles or bent plates.
 - b. Predrilled to accept two fasteners each.
 - c. Weld angles or bent plates to vertical posts.
 - d. Provide toeboards on walkway side of all elevated walkways, platforms and stair landings, and where indicated on the Drawings or required by OSHA Standards.
 - 1) 4 IN high extruded toeboard with stiffener ribs and angled toe.
 - a) Similar to Wagner, Model "IR94102."
 - e. Guardrail gates:
 - 1) Constructed of same material and sizes as the guardrail system.
 - 2) Width of gate as shown on Drawings.
 - 3) Hinges:
 - a) Cast aluminum.
 - b) Self-closing.
 - (1) Stainless steel torsion spring.
 - c) Similar to Wagner, Model "IR100."
 - 4) Gate latch and stop:
 - a) Cast aluminum.
 - b) Spring-loaded pin latch.
 - (1) Stainless steel spring.
 - c) Similar to Wagner, Model "IR101."
- C. Railing Fabrication:
- 1. All railings are to be welded systems.
 - 2. Use wire welding for all joints.
 - 3. All welding to be continuous in accordance with AWS C5.5 and AWS D1.2.
 - a. All welded railing joints shall have full penetration welds unless noted otherwise.
 - 4. All exposed welds to be ground smooth and flush to match and blend with adjoining surfaces.
 - a. NAAMM AMP 521, Type 2.
 - 5. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
 - 6. Finishing joints with filler is not acceptable.
 - 7. Provide flush weld fittings using locking weld connectors or coped drive-on connectors.
 - 8. Fit exposed ends of guardrails and handrails with solid terminations.
 - a. Return ends of handrail to wall, but do not attach to wall.
 - b. Where guardrail terminates at a wall, provide a vertical post or end-loop 4 IN off the wall to center of vertical member.
 - 9. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.
 - 10. Install weeps to drain water from hollow sections of railing at exterior and high humidity conditions.
 - a. Drill 1/4 IN weep hole in railings closed at bottom:
 - 1) 1 IN above walkway surface at bottom of posts set in concrete.
 - 2) 1 IN above solid aluminum rod at posts having base plate.
 - 3) At low point of intermediate rails.
 - b. Do not drill weep holes:
 - 1) In bottom of base plate.
 - 11. Expansion joints:
 - a. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.

- 1) Top rail splices and expansion joints shall be located within 8 IN of post or other support.
 - 2) Where railings span building or tank expansion joints; provide a railing expansion joint in the span crossing the building or tank expansion joint.
 - b. Provide expansion joints in any continuous run exceeding 20 FT in length.
 - 1) Space expansion joints at not more than 40 FT on center.
 - c. Provide minimum 0.10 IN of expansion joint for each 20 FT length of top rail for each 25 DEGF differential between installation temperature and maximum design temperature.
 - 1) Maximum expansion joint width at time of installation shall not exceed 3/8 IN.
 - a) Provide additional expansion joints as required to limit expansion joint width.
 - d. Provide slip-joint with internal sleeve.
 - 1) Extend slip joint min 2 IN beyond joint at maximum design width.
 - 2) Fasten internal sleeve securely to one side.
 - a) Provide allen-head set screw located in bottom of rail.
 - b) Rivets or exposed screw heads are not acceptable.
- D. Finish:
1. Mill.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to installation, inspect and verify condition of substrate.
- B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
 1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

- A. Install handrails and guardrails to meet loading requirements of the building code.
- B. Install products in accordance with manufacturer's instructions.
- C. Set work accurately in location, alignment and elevation; plumb, level and true.
 1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.
- D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
 1. Provide shims as required.
- E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
 1. Lubricate expansion joint splice bar for smooth movement of railing sections.
- F. Provide removable railing sections where indicated on Drawings.
- G. Attach handrails to walls or guardrail with brackets designed for condition:
 1. Provide brackets which provide a minimum 1-1/2 IN clearance between handrail and nearest obstruction.
 - a. Handrails shall not project more than 4-1/2 IN into required stairway width.
 2. Anchor handrail brackets to concrete or masonry walls with 1/2 IN stainless steel adhesive anchors with stainless steel hex head bolts.
- H. Anchor railings to concrete with minimum 1/2 IN stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract Documents.
 1. Where exposed, bolts shall extend minimum 1/2 IN and maximum 3/4 IN above the top nut.

- a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
 - b. Bevel the top of the bolt after cutting to provide a smooth surface.
- I. Anchor railings to metal structure with minimum 3/4 IN stainless steel bolts, nuts and washers.
- J. Install toeboards to fit tight to the walking surface.
 - 1. Attach to railing vertical post with manufacturer's standard mounting clamp:
 - a. Adjustable.
 - b. Designed to engage in extruded slot on back of toeboard.
 - 2. Provide splice bars, corner splices and brackets:
 - a. Manufacturer's standard items as required for a complete installation.
 - 3. Notch toeboards at base plates or other obstructions.
 - 4. Bottom of toeboard shall not exceed 1/4 IN above walking surface.
- K. Coat aluminum in contact with dissimilar metal or concrete in accordance with Specification Section 09 96 00.
- L. Provide railings as required for stair construction identified in Specification Section 05 50 00.
- M. Install guardrail gate plumb and level in location shown on Drawings.
 - 1. Center gate in opening.
 - 2. Top of gate to match top of guardrail.
 - 3. Fasten hinges to gate and jamb post:
 - a. Minimum three, 1/4 IN stainless steel countersunk machine screws per leaf.
 - b. Drill and tap into railing and gate vertical posts.
 - 4. Provide not less than two hinges per gate.
 - 5. Install gate latch and stop on strike side of opening.
 - a. Fasten to gate with 1/4 IN stainless steel countersunk machine screws.
 - b. Drill and tap into gate vertical post.
 - c. Drill hole in railing vertical post to receive latch pin.
 - 6. Adjust to provide smooth operation:
 - a. Self-closing and self-latching.

END OF SECTION



DIVISION 08

OPENINGS



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SECTION 08 33 23
STEEL ROLLING OVERHEAD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel rolling overhead doors.
 - 2. Motor Operators.
 - 3. Control Systems.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American National Standards Institute (ANSI).
 - 2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - a. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - 3. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - f. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - g. A501/A501M, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - h. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - i. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - j. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - k. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - l. F3125/F3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
 - 4. Door & Access Systems Manufacturers' Association, International (DASMA):
 - a. ANSI/DASMA 108, Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.
 - 5. International Energy Conservation Code (IECC).
 - 6. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

7. Underwriters Laboratories, Inc. (UL):
 - a. 325, Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.
- B. Qualifications:
 1. Installer to be licensed or approved in writing by door manufacturer.

1.3 DEFINITIONS

- A. Installer or Applicator:
 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Manufacturer's standard color charts.
 3. Schedule of doors using same reference number for openings as indicated on Drawings.
 4. Motor operator and accessories technical data including complete wiring and control diagrams.
 5. Certifications:
 - a. Certification of installer qualifications.
 6. Test Reports:
 - a. Test report showing compliance with ASTM E330 or ANSI/DASMA 108 for the design pressure based on the wind speed specified.
- B. Samples:
 1. Actual metal color samples of manufacturer's full line of colors available.
- C. Contract Closeout Information:
 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- D. Informational Submittals:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Steel rolling overhead doors:
 - a. CornellCookson.
 - b. Wayne Dalton.
 - c. Overhead Door Corporation.
 - d. Raynor Garage Doors.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design Wind Load:
 - 1. Test door assemblies in accordance with ASTM E330 or ANSI/DASMA 108.
 - 2. Exterior doors:
 - a. Determine static pressure in accordance with applicable test method.
 - b. Basic Wind Load Design Criteria: See.
 - 3. Interior doors: 20 PSF minimum.
- B. Air Infiltration:
 - 1. Meet ASHRAE 90.1 and IECC 2012/2015 C402.4.3.
 - 2. Air leakage: <1.00 CFM/SQFT.
- C. Thermal performance:
 - 1. NFRC test report: U-factor: 0.91.
- D. Sound Rating:
 - 1. ASTM E90.
 - 2. Minimum assembly rating: STC-21.

2.3 MATERIALS

- A. Steel:
 - 1. Hot dipped galvanized:
 - a. Fasteners: ASTM A153/A153M.
 - b. All other components: ASTM A123/A123M.
 - 2. Bars, shapes, and plate: ASTM A36/A36M.
 - 3. Pipe: ASTM A53/A53M or A501/A501M.
 - 4. Tubing: ASTM A500/A500M.
 - 5. Bolts and nuts: ASTM A307 or F3125/F3125M.
- B. Insulation:
 - 1. Closed cell polyurethane foam.
 - 2. CFC free.
- C. Weatherproofing:
 - 1. Resilient: Neoprene or vinyl.
 - 2. Brush type: Nylon or polypropylene.
- D. Fasteners: Same material as door construction.

2.4 MANUFACTURED UNITS

- A. Door Curtain:
 - 1. Insulated flat profile:
 - a. Overhead Door Corp. "625 Series".
 - b. 2-5/8 IN high.
 - c. Interlocking face sheets:
 - 1) Exterior face: 0.040 IN.
 - 2) Interior face: 0.024 IN.
 - d. Galvanized endlocks.
 - e. Core: Insulated.
 - 2. Bottom bar:
 - a. Two structural angles bolted back-to-back.
 - 1) Minimum 1/8 IN thick.
- B. Operation:
 - 1. Motor operated with integral chain hoist backup.

- C. Guides:
 - 1. Manufacturer's standard structural angle guide system for size of door specified.
 - a. Galvanized Steel.
 - b. Furnish curtain wind locks as necessary for design wind load.
 - 2. Mounting:
 - a. Interior face of wall.
 - 3. Cold-rolled guides are not acceptable.
- D. Headplates:
 - 1. Sized to support counterbalance assembly, curtain, motor operator and hood.
 - a. Field verify headroom and side clearances and coordinate motor operator mounting accordingly.
- E. Counterbalance Assembly:
 - 1. Pipe barrel:
 - a. Galvanized Steel.
 - b. Maximum deflection: 0.03 IN/FT.
 - 2. Torsion springs:
 - a. Oil-tempered helical torsion springs on cast anchors.
 - b. 100,000 cycle.
 - 3. Adjustable tension wheel.
- F. Hood:
 - 1. Minimum 24 GA.
 - 2. Air baffle extending full length.
- G. Weatherstripping:
 - 1. Guide tracks: Exterior and interior weatherseal.
 - 2. Lintel: Brush-type weatherseal.
 - 3. Bottom seal:
 - a. Motor-operated doors: Electric safety edge.
- H. Finish:
 - 1. Powder coat:
 - a. Factory prime and finish coats.
 - b. Prime coat: Minimum 0.2 MIL baked-on prime paint.
 - c. Finish coat: Minimum 0.6 MIL baked-on polyester powder coat.
 - d. Color:
 - 2. Trim Pieces: Material and finish to match door curtain.

2.5 ACCESSORIES

- A. Motor Operator:
 - 1. Minimum 1/2 HP with integral brake.
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - b. Motor shall be sized by door manufacturer for door size indicated on Drawings.
 - 2. Opening/Closing rate: Between 2/3 and 1 FPS.
 - 3. See Specification Section 01 61 03 for additional motor requirements.
 - a. Provide manufacturer's standard reversing controller with motor thermal protection if motor is not internally protected as specified in Specification Section 01 61 03.
 - 4. Provide enclosures with the required rating per NEMA 250 to meet classifications identified in the Contract Documents.
 - 5. Provide integral backup chain hoist and release with integrated interlock.
 - a. Provide chain keeper for each hoist.
 - 6. Control System:
 - a. General:
 - 1) Control system shall be hard wired to the operator power supply or a DC power transformer.
 - a) Battery powered control stations or receivers are not acceptable.

- 2) Provide complete wiring connections from control system to motor operator including all intermediate junction boxes, conduit, disconnects, and wiring.
 - a) Wireless control stations or entrapment protection components are not acceptable.
- b. Manual control station:
 - 1) Interior controls: Surface mounted.
 - a) Pushbutton operation: Open, Close, Stop.
- c. Entrapment protection:
 - 1) Comply with UL 325.
 - a) Instant reversing.
 - b) When activated shall prevent operator from closing an open door.
 - 2) Electric safety edge:
 - a) Contact-type sensor installed on leading edge of the door.
 - b) When activated shall prevent operator from closing an open door.
 - c) Safety edge on exterior doors shall act as a weatherseal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Installation shall be done by manufacturer's authorized representative.
- C. Provide all required trim, weatherstripping, closures etc., for complete weather tight installation.
- D. Adjust for proper counter balance.
- E. Seal along bottom of vertical track (guides), seal the vertical joint between the two separate track angles (if not filled by welding) and seal all holes in vertical track (not being used for fasteners) to provide a completely weather tight track and door system.
 - 1. At fastener locations provide steel washers under bolt head to completely cover the slotted holes in the vertical track.
 - a. Finish of steel washer shall match finish of track (guides).
- F. Electrical disconnect and conduit and wiring from standard three pushbutton control to motor operator is provided in the Electrical Design.
- G. Provide bracing for motor operator to eliminate vibration.

3.2 ADJUSTMENT

- A. Prior to occupancy, adjust door for smooth operation.

END OF SECTION

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DIVISION 10

SPECIALTIES



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SECTION 10 14 00
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items.
 - 2. Hazard and safety signs.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. A13.1, Scheme for the Identification of Piping Systems.
 - 2. The International Society of Automation (ISA).
 - 3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. Z535.1, Safety Color Code.
 - b. Z535.2, Environmental and Facility Safety Signs.
 - c. Z535.3, Criteria for Safety Symbols.
 - d. Z535.4, Product Safety Signs and Labels.
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 704, Standard System for the Identification of Hazards of Materials for Emergency Response.
 - 5. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Catalog information for all identification systems.
 - b. Acknowledgement that products submitted meet requirements of standards referenced.
 - 3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.
 - 4. Schedule of Hazard and Safety Signage indicating text and graphics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. W.H. Brady Co.
 - 2. Panduit.
 - 3. Seton.
 - 4. National Band and Tag Co.

5. Carlton Industries, Inc.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

- A. Type A1 - Round Metal Tags:
 1. Materials:
 - a. Aluminum or stainless steel.
 - b. Stainless steel shall be used in corrosive environments.
 2. Size:
 - a. Diameter: 1-1/2 IN minimum.
 - b. Thickness: 0.035 IN (20 GA) minimum.
 3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - b. Legend: Stamped and filled with black coloring.
 4. Color: Natural.
- B. Type A2 - Rectangle Metal Tags:
 1. Materials: Stainless steel.
 2. Size:
 - a. 3-1/2 IN x 1-1/2 IN minimum.
 - b. Thickness: 0.036 IN (20 GA) minimum.
 3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - b. Legend: Stamped and filled with black coloring.
 4. Color: Natural.
- C. Type A3 - Metal Tape Tags:
 1. Materials: Aluminum or stainless steel.
 2. Size:
 - a. Width 1/2 IN minimum.
 - b. Length as required by text.
 3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - b. Legend: Embossed.
 4. Color: Natural.
- D. Type B1- Square Nonmetallic Tags:
 1. Materials: Fiberglass reinforced plastic.
 2. Size:
 - a. Surface: 2 x 2 IN minimum.
 - b. Thickness: 100 MILS.
 3. Fabrication:
 - a. 3/16 IN mounting hole with metal eyelet.
 - b. Legend: Preprinted and permanently embedded and fade resistant.
 4. Color:
 - a. Background: Manufacturer standard or as specified.
 - b. Lettering: Black.
- E. Type B2 - Nonmetallic Signs:
 1. Materials: Fiberglass reinforced or durable plastic.
 2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 60 MILS minimum.
 3. Fabrication:
 - a. Rounded corners.
 - b. Drilled holes in corners with grommets.

- c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
 - 4. Color:
 - a. Background: Manufacturer standard or as specified.
 - b. Lettering: Black.
 - 5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.
- F. Type C - Laminated Name Plates:
 - 1. Materials: Phenolic or DR (high impact) acrylic.
 - 2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 1/16 IN.
 - 3. Fabrication:
 - a. Outdoor rated and UV resistant when installed outdoors.
 - b. Two layers laminated.
 - c. Legend: Engraved through top lamination into bottom lamination.
 - d. Two drilled side holes, for screw mounting.
 - 4. Color: Black top surface, white core, unless otherwise indicated.
- G. Type D - Self-Adhesive Tape Tags and Signs:
 - 1. Materials: Vinyl tape or vinyl cloth.
 - 2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 5 MILS minimum.
 - 3. Fabrication:
 - a. Indoor/Outdoor grade.
 - b. Weather and UV resistant inks.
 - c. Permanent adhesive.
 - d. Legend: Preprinted.
 - e. Wire markers to be self-laminating.
 - 4. Color: White with black lettering or as specified.
 - 5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.
- H. Type E - Heat Shrinkable Tape Tags:
 - 1. Materials: Polyolefin.
 - 2. Size: As required by text.
 - 3. Fabrication:
 - a. Legend: Preprinted.
 - 4. Color: White background, black printing.
- I. Type F - Underground Warning Tape:
 - 1. Materials: Polyethylene.
 - 2. Size:
 - a. 6 IN wide (minimum).
 - b. Thickness: 3.5 MILS.
 - 3. Fabrication:
 - a. Legend: Preprinted and permanently imbedded.
 - b. Message continuous printed.
 - c. Tensile strength: 1750 PSI.
 - 4. Color: As specified.
- J. Type G - Stenciling System:
 - 1. Materials:
 - a. Exterior type stenciling enamel.
 - b. Either brushing grade or pressurized spray can form and grade.
 - 2. Size: As required.

3. Fabrication:
 - a. Legend: As required.
 4. Color: Black or white for best contrast.
- K. Underground Tracer Wire:
1. Materials:
 - a. Wire:
 - 1) 12 GA AWG.
 - 2) Solid.
 - b. Wire nuts: Waterproof type.
 - c. Split bolts: Brass.

2.3 ACCESSORIES

- A. Fasteners:
1. Bead chain: #6 brass, aluminum or stainless steel.
 2. Plastic strap: Nylon, urethane or polypropylene.
 3. Screws: Self-tapping, stainless steel.
 4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

- A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install identification devices at specified locations.
- B. All identification devices to be printed by mechanical process, hand printing is not acceptable.
- C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.
- D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
 1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.
- E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
 1. Several items of equipment mounted in housing to be individually tagged inside the compartment.
- F. Tracer Wire:
 1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
 2. Continuous pass from each valve box and above grade at each structure.
 3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
 4. 1,000 FT maximum spacing between valve boxes.
 5. If split bolts are used for splicing, wrap with electrical tape.
 6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
 7. Use continuous strand of wire between valve box where possible.
 - a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

- A. Hazard and Safety Signage:
1. Engineer Hazardous Material Identification Signage:
 - a. Tag Type: Type B2 - Nonmetallic Signs.

- b. Fastener: Screw or adhesive.
 - c. Size (NFPA Diamond): Per NFPA 704, 10" minimum.
 - d. Size (Hazardous Material name, with concentration % where applicable): 2 IN minimum letters, directly below corresponding NFPA Diamond.
 - e. Location: On the doors entering into the rooms with Hazardous Material and on the tanks or storage containers of Hazardous Materials, as indicated on the Drawings.
 - f. Location: Field located as directed by Owner.
 - 1) Allowance: Provide 2 NFPA 704 Diamond signs.
 - 2) Allowance: Provide 2 for Hazardous Material Name.
 - g. Legend:
 - 1) NFPA 704 Diamond hazard numbers: As directed by Owner appropriate for the Hazardous Material.
 - 2) Hazardous Material name: As directed by Owner.
- B. Process Systems:
- 1. General:
 - a. Provide arrows and markers on piping.
 - 1) At 20 FT maximum centers along continuous lines.
 - 2) At changes in direction (route) or obstructions.
 - 3) At valves, risers, "T" joints, machinery or equipment.
 - 4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
 - b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
 - 1) If flow is in both directions use double headed arrow markers.
 - c. Apply tapes and stenciling in uniform manner parallel to piping.
 - 2. Trenches with piping:
 - a. Tag type: Type F - Underground Warning Tape
 - b. Location: Halfway between top of piping and finished grade.
 - c. Letter height: 1-1/4 IN minimum.
 - d. Potable water:
 - 1) Color: Blue with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED WATER LINE BELOW"
 - e. Storm and sanitary sewer lines:
 - 1) Color: Green with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED SEWER LINE BELOW"
 - f. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
 - 1) Color: Green with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED NONPOTABLE WATER LINE BELOW"
 - g. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.):
 - 1) Color: Yellow with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED CHEMICAL LINE BELOW"
 - h. Other piping (e.g., compressed air, irrigation, refrigerant, heating water, etc.):
 - 1) Color: Yellow with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED PIPE LINE BELOW"
 - 3. Yard valves, buried, with valve box and concrete pad:
 - a. Tag type: Type A2 - Rectangle Metal Tags.

- b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).
- 4. Valves and slide gates:
 - a. Tag type:
 - 1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
 - 2) Indoor noncorrosive:
 - a) Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - 3) Indoor corrosive:
 - a) Stainless steel Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - b. Fastener:
 - 1) Type A1: Chain of the same material.
 - 2) Type B1: Stainless steel chain.
 - c. Color: Per ASME A13.1 corresponding to the piping system.
 - d. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).
- 5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type D - Self-Adhesive Tape Tags and Signs.
 - 3) Type G - Stenciling System.
 - b. Fastener:
 - 1) Self.
 - 2) Screws.
 - 3) Adhesive.
 - c. Legend:
 - 1) Letter height: 1/2 IN minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).
- 6. Piping systems:
 - a. Tag type:
 - 1) Outdoor locations: Type G - Stenciling System.
 - 2) Indoor locations:
 - a) Type D - Self-Adhesive Tape Tags and Signs.
 - b) Type G - Stenciling System.
 - b. Fastener: Self.
 - c. Color: Per ASME A13.1.
 - d. Legend:
 - 1) Letter height: Manufacturers standard for the pipe diameter.
 - 2) Mark piping in accordance with ASME A13.1.
 - 3) Use piping designation as indicated on the Drawings.
 - 4) Arrow: Single arrow.
- 7. Process tanks (over 1000 GAL) and basins, (e.g., chemical storage, clarifiers, trickling filters, digesters, etc.):
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type G - Stenciling System.
 - b. Fastener:
 - 1) Screw.
 - 2) Self.

- c. Location as directed by Owner.
 - d. Legend:
 - 1) Letter height: 4 IN minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., “Clarifier CL-xxx”).
 - 8. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):
 - a. Tag type:
 - 1) Type D - Self-Adhesive Tape Tags and Signs.
 - 2) Type G - Stenciling System.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 2 IN minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., “Polymer Storage Tank Txxx”)
 - 9. Equipment that starts automatically:
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener:
 - 1) Type B2 - Screw or adhesive.
 - 2) Type D - Self.
 - c. Size: 5 IN x 7 IN
 - d. Location: Equipment name.
 - e. Legend:
 - 1) OSHA Warning Sign.
 - 2) Description of Warning: “THIS MACHINE STARTS AUTOMATICALLY”.
- C. Instrumentation Systems:
- 1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
 - a. Tag type:
 - 1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
 - 2) Indoor noncorrosive:
 - a) Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - 3) Indoor corrosive:
 - a) Stainless steel Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - b. Fastener:
 - 1) Type A1: Chain of the same material.
 - 2) Type B1: Stainless steel chain.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).
 - 2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/2 IN minimum.
 - 2) Equipment name (e.g., “PLC CONTROL PANEL PCP-xxx”).
 - 3. Components inside equipment enclosure, (e.g., PLC’s, control relays, contactors, and timers):
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 IN minimum.
 - 2) Description or function of component (e.g., “PLC-xxx” or “CR-xxx”).

4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

D. HVAC Systems:

1. General:
 - a. Provide arrows and markers on ducts.
 - 1) At 20 FT maximum centers along continuous lines.
 - 2) At changes in direction (route) or obstructions.
 - 3) At dampers, risers, branches, machinery or equipment.
 - 4) Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
 - b. Position markers on both sides of duct with arrow markers pointing in flow direction.
 - 1) If flow is in both directions use double headed arrow markers.
 - c. Apply tapes and stenciling in uniform manner parallel to ducts.
2. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1 IN minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").
3. Ductwork:
 - a. Tag type:
 - 1) Type D - Self-Adhesive Tape Tags and Signs.
 - 2) Type G - Stenciling System.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 1 IN minimum.
 - 2) Description of ductwork, (e.g., "AIR SUPPLY").
 - 3) Arrows: Single arrow.
4. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/2 IN minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").
5. Wall mounted thermostats:
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 IN minimum.
 - 2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").
6. Components inside equipment enclosure, (e.g., controller's, control relays, contactors, and timers):
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 IN minimum.
 - 2) Description or function of component (e.g., "CR-xxx").

7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
- E. Electrical Systems:
1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
 - a. Tag type: Type F - Underground Warning Tape.
 - b. Letter height: 1-1/4 IN minimum.
 - c. Location:
 - 1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
 - 2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
 - d. Electrical power (e.g., low and medium voltage):
 - 1) Color: Red with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION".
 - b) Second line: "BURIED ELECTRIC LINE BELOW".
 - e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
 - 1) Color: Orange with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION".
 - b) Second line: "BURIED COMMUNICATION LINE BELOW".
 2. Switchgear, switchboards and motor control centers:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Main equipment legend:
 - 1) Letter height:
 - a) First line: 1 IN minimum.
 - b) Subsequent lines: 3/8 IN minimum.
 - 2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
 - 3) Second line:
 - a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
 - b) Include the building name or number if the source is in another building.
 - 4) Third line: System voltage and phase (e.g., "480/277 V, 3PH").
 - 5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
 - d. Main and feeder device legend:
 - 1) Letter height: 3/8 IN minimum.
 - 2) Description of load (e.g., "MAIN DISCONNECT", "PUMP Pxxx" or "PANELBOARD HPxxx").
 3. Panelboards and transformers:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height:
 - a) First line: 3/8 IN minimum.
 - b) Subsequent lines: 3/16 IN minimum.
 - 2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
 - 3) Second line (panelboards only): System voltage and phase (e.g., "208/120V, 3PH").

- 4) Third line:
 - a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
 - b) Include the building name or number if the source is in another building.
 - 5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
4. Transfer switches:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height:
 - a) First line: 3/8 IN minimum.
 - b) Subsequent lines: 3/16 IN minimum.
 - 2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").
 - 3) Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCCxxx").
 - 4) Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGENxxx").
 - 5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
5. Safety switches, separately mounted circuit breakers and motor starters, VFD's, etc.:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
 - 3) Second line:
 - a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
 - b) The source of power room number is only required when there are multiple electrical rooms, if the source is in another building, the building name or number shall be used.
6. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/2 IN minimum.
 - 2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
7. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 IN minimum.
 - 2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").
8. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 IN minimum.
 - 2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
9. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - b. Fastener: Self.
 - c. Tag conductor at both ends.
 - d. Legend:
 - 1) Letter height: 1/8 IN minimum.

- 2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
- 10. Conductors in handholes and manholes.
 - a. Tag type: Type A3 - Metal Tape Tags.
 - b. Fastener: Nylon strap.
 - c. Tag conductor at both ends.
 - d. Legend:
 - 1) Letter height: 1/8 IN minimum.
 - 2) Circuit number or wire number as scheduled on the Drawings.
- 11. Grounding conductors associated with grounding electrode system in accordance with the following:
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 1/8 IN minimum.
 - 2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
- 12. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
 - a. Tag type: Type D - Self-Adhesive Tape Signs.
 - b. Fastener: Self.
 - c. Legend: Per NFPA 70.
- 13. Entrances to electrical rooms:
 - a. Tag type: Type B2 - Nonmetallic Signs.
 - b. Fastener: Screw or adhesive.
 - c. Size: 5 IN x 7 IN.
 - d. Location: Each door to room.
 - e. Legend:
 - 1) OSHA Danger Sign.
 - 2) Description of Danger: "HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY".
- 14. Equipment where more than one voltage source is present:
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type D - Self-Adhesive Tape Signs.
 - b. Fastener:
 - 1) Screw or adhesive.
 - 2) Self.
 - c. Size: 1-3/4 IN x 2-1/2 IN.
 - d. Location: Exterior face of enclosure or cubical.
 - e. Legend:
 - 1) OSHA Danger Sign.
 - 2) Description of Danger: "MULTIPLE VOLTAGE SOURCES".

END OF SECTION

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SECTION 10 14 23

SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Room identification signs.
 - 2. Other identification signs:
 - a. Fire and/or smoke barrier identification signs.
 - 3. Aluminum letters.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Americans with Disabilities Act (ADA):
 - a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - 2. ASTM International (ASTM):
 - a. B26, Standard Specification for Aluminum-Alloy Sand Castings.

1.3 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.
- B. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the following rooms or areas are considered wet and/or corrosive:

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Color charts for Engineer's color selection.
 - 1) Color selection shall be made from manufacturer's complete color line including all premium and special colors.
 - 3. Schedule of all signs indicating text and graphics.
 - 4. Layout drawings of all signage showing size, letter style, text, border, finish, and installation detail.
 - a. Provide drawings for:
 - 1) Room and exit identification signs.
 - 2) Fire and/or smoke barrier identification signs.
 - 3) Aluminum letters.
- B. Samples:
 - 1. Fire and/or smoke barrier identification signs.
 - 2. Aluminum letters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Room, exit and stair identification signs:
 - a. ASE - Architectural Signs and Engraving.
 - b. ASI Signage Innovations.
 - c. Best Sign Systems.
 - d. Mohawk Sign Systems.
 - e. Nelson-Harkins.
 - f. Southwell Co.
 - g. Stamprite Supersine Identification Specialists.
 - 2. Fire and/or smoke barrier identification signs:
 - a. Brady.
 - b. Panduit.
 - c. Seton.
 - d. Carlton Industries.
 - 3. Aluminum letters:
 - a. A R K Ramos Manufacturing Co., Inc.
 - b. ASI Signage Innovations.
 - c. Leeds Architectural Letters.
 - d. Metal Arts.
 - e. Metallic Arts.
 - f. The Southwell Co.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

- A. Room and Exit Identification Signs:
 - 1. Interior:
 - a. Dry, non-corrosive areas: Melamine plastic suitable for raised lettering and Braille.
 - b. Wet and/or corrosive areas: Aluminum or fiberglass suitable for raised lettering and Braille.
 - 2. Exterior: Aluminum or fiberglass suitable for raised lettering and Braille.
- B. Fire and/or Smoke Barrier Identification Signs:
 - 1. Self-adhesive vinyl tape or vinyl cloth.
- C. Aluminum Letters:
 - 1. Cast aluminum ASTM B26.
 - 2. For machine cut letters, provide aluminum of appropriate alloy and hardness.

2.3 FABRICATION

- A. Room and Exit Identification Signs:
 - 1. General:
 - a. Raised text, border and graphics.
 - 1) Minimum 1/32 IN height.
 - 2) Provide international graphic symbology for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
 - 3) Provide handicap symbol on all signs for rooms meeting handicap requirements.
 - b. Grade 2 Braille.
 - c. Finish: Eggshell.
 - 1) Color: To be selected.
 - d. Text:
 - 1) Typeface: Sans Serif.
 - 2) Size: Minimum 3/4 IN high.

- e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.
 - f. Exterior signs shall be rated for exterior use.
 - g. All signs shall comply with requirements of ADA state or local authority, if appropriate.
- B. Fire and/or Smoke Barrier Identification Signs:
- 1. Self-adhesive tape tags and signs:
 - a. Materials: Vinyl tape or vinyl cloth.
 - 1) Indoor/Outdoor grade.
 - 2) Weather and UV resistant inks.
 - 3) Permanent adhesive.
 - b. Size:
 - 1) Surface: As required by text.
 - 2) Thickness: 5 MILS minimum.
 - c. Color: White with black lettering.
 - 2. Typeface: Helvetica Medium.
 - 3. Text Size:
 - a. Height: 3 IN minimum.
 - b. Stroke: 3/8 IN minimum.
 - c. Text: As indicated in the SCHEDULES Article in PART 3Fabrication:
- C. Hazard Communication Signage (NFPA and OSHA signage): See Specification Section 10 14 00.
- D. Aluminum Letters:
- 1. General:
 - a. Cast aluminum, machine cut or laser cut aluminum.
 - b. Finish: Baked enamel.
 - c. Color: _Black_
 - d. Mounting:
 - 1) 1 IN projected.
 - 2) Provide stainless steel mounting studs.
 - e. Text: As indicated in the SCHEDULES Article in PART 3.
 - 2. Letters:
 - a. Typeface: Helvetica Medium.
 - b. Size:
 - 1) Height: 8 IN.
 - 2) Stroke: 1/2 IN minimum.
 - c. Depth: 3/8 IN.
 - 3. Provide true angles, crisp corners and straight edges with no burrs or pitting in the surface.
- E. Site Signs:

2.4 MAINTENANCE MATERIALS

- A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Room Identification Signs:
 - 1. Install signs using foam tape for interior signs and stainless steel screws (minimum of two) for exterior signs.
 - a. Stainless steel screws shall be painted to match sign color.
 - 2. Mounting Locations:
 - a. Tactile characters on signs shall be located 48 IN minimum above the finished floor or ground surface, measured from the baseline of the lowest tactile character and 60 IN

maximum above the finish floor or ground surface, measured from the baseline of the highest tactile character.

- b. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf. Where a tactile sign is provided at double doors with two active leaves, the sign shall be located to the right side of the right hand door. Where there is no wall space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.
- c. Signs containing tactile characters shall be located so that a clear floor space of 18 IN minimum by 18 IN minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
3. Interior and exterior signs identifying permanent rooms and spaces shall comply with ADA state or local authority, if appropriate.

B. Fire and/or Smoke Barrier Identification Signs:

1. Provide marking and identification in compliance with building code.
2. Locate in accessible concealed floor, floor-ceiling, or attic spaces.
3. Locate within 15 FT of the end of each wall or partition and at intervals not exceeding 30 FT horizontally.

C. Aluminum Letters:

1. Install letters where indicated on Drawings.
2. Mount to walls with 1 IN projection in accordance with manufacturer's instructions.

3.2 SCHEDULES

A. Room and Exit Identification Signs:

BUILDING LOCATION	MOUNTING	VERBIAGE	REMARKS
OPERATIONS BUILDING			
DOOR 11-102A	EXTERIOR	OFFICE	2
DOOR 11-102B	INTERIOR	OFFICE	3
DOOR 11-103A	EXTERIOR	MAINTENANCE	2
DOOR 11-103D	INTERIOR	MAINTENANCE	3
DOOR 11-104A	INTERIOR	LUNCH ROOM	3
DOOR 11-105A	INTERIOR	WOMEN	1, 3
DOOR 11-106A	INTERIOR	MEN'S LOCKER ROOM	1, 3
DOOR 11-107A	EXTERIOR	OPERATIONS	2
DOOR 11-108A	INTERIOR	INVENTORY	3
DOOR 11-108A	INTERIOR	INVENTORY	2
SLUDGE HANDLING BUILDING			
DOOR 11-109A	EXTERIOR	TRUCK LOADING	2
DOOR 11-109C	EXTERIOR	TRUCK LOADING	2
DOOR 11-109E	EXTERIOR	TRUCK LOADING	2
DOOR 11-110A	EXTERIOR	AUXILLIARY STORAGE	2
DOOR 11-111A	INTERIOR	POLYMER STORAGE	2
DOOR 11-112A	INTERIOR	STAIR	1, 3

BUILDING LOCATION	MOUNTING	VERBIAGE	REMARKS
DOOR 11-112A	INTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-112B	INTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-112B	INTERIOR	TRUCK LOADING	3
DOOR 11-112C	EXTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-113A	EXTERIOR	STAIR	2
DOOR 11-202A	INTERIOR	SLUDGE DEWATERING	2
DOOR 11-203A	INTERIOR	UNISEX RESTROOM	1, 3
DOOR 11-204A	INTERIOR	OPERATOR ROOM	2
DOOR 11-204A	INTERIOR	STAIR	1, 3
DOOR 11-204B	INTERIOR	SLUDGE THICKENING	2
DOOR 11-204B	INTERIOR	OPERATOR ROOM	3
DOOR 11-205A	INTERIOR	ELECTRICAL ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-205B	INTERIOR	ELECTRICAL ROOM AUTHORIZED PERSONNEL ONLY	3
DOOR 11-206A	EXTERIOR	SLUDGE THICKENING	2
DOOR 11-207A	INTERIOR	UTILITY ROOM	2
DOOR 11-208B	INTERIOR	STAIR	1, 3
DOOR 11-208B	INTERIOR	SLUDGE DEWATERING	2
DOOR 11-208C	INTERIOR	ROOF ACCESS AUTHORIZED PERSONNEL ONLY	3
REMARKS: 1. Provide Universal Graphic Symbolology. 2. Mount adjacent to pull side of door. 3. Mount adjacent to push side of door.			

B. Fire and/or Smoke Barrier Identification Signs:

ASSEMBLY	VERBIAGE
Fire Walls	____ HR FIRE WALL - PROTECT ALL OPENINGS
Fire Barriers	____ HR FIRE BARRIER - PROTECT ALL OPENINGS
Fire Partitions	____ HR FIRE PARTITION - PROTECT ALL OPENINGS
Smoke Barriers	____ HR SMOKE BARRIER - PROTECT ALL OPENINGS
Smoke Partitions	____ HR SMOKE PARTITION - PROTECT ALL OPENINGS

ASSEMBLY	VERBIAGE
Fire and Smoke Barriers	_____HR FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS
Fire and Smoke Partitions	_____HR FIRE AND SMOKE PARTITION - PROTECT ALL OPENINGS

1. Indicate hourly rating of assembly.
 2. Verify exact verbiage with AHJ prior to fabricating signage.
- C. Aluminum Letters:
1. As indicated on the Drawings.

END OF SECTION



DIVISION 11
EQUIPMENT



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SECTION 11 15 50
FIBER-REINFORCED PLASTIC TANKS WITH FRP BOTTOMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Supply and install fish culture (including but not limited to covered area and outdoor) tank(s) in accordance with the General Conditions. The fish culture tank(s) includes fish exclusion screens, sumps, side boxes, overflow boxes, release boxes and standpipes (internal or external depending on schedule herein and Drawings) for water level control, and all appurtenances and components necessary to provide a complete and fully functional fish culture tank system.

1.2 REFERENCES

- A. Commercial Standards
1. ASTM, American Society for Testing and Materials
 2. AWS, American Welding Society
 3. ANSI/ASME, Performance Test Code
 4. AWWA, American Water Works Association
 5. MSS, Manufacturers Standardization Society of the Valve and Fitting Industry

1.3 SUBMITTALS

- A. Product Data and Shop Drawings: Submit complete assembly and installation drawings, design calculations and product data for the fish culture tank equipment as a complete system, in accordance with Section 01 33 00 Submittals. The following are to be included in the submittal:
1. Product data and shop drawings for approval as per Section 01 33 00 Submittals. Drawings are to show locations and connections of water inlet and outlet.
 2. Complete set of design calculations for each size tank furnished.
 3. Equipment name and applicable specification number
 4. Product data including:
 - a. Dimensions and capacity.
 - b. Components including resin and reinforcement.
 - c. Tank construction materials.
 - d. Exact pipe connection sizes, types and locations.
 - e. Schematic flow diagrams showing piping and equipment.
 - f. Floor and wall slopes.
 - g. Tank interior and exterior color.
 - h. Finishes including UV absorbers, pigments and gelcoats.
 - i. Weights and thicknesses.
 - j. Specifications for accessory items.
 - k. Manufacturer's printed literature for care and maintenance.
 - l. Samples of available colors including 12" x 12" samples of equipment to be furnished in required thickness.
 5. Assembly and Installation Drawings: Complete assembly and installation drawings and instructions including piping, equipment assemblies, required clearances, method of field assembly, location and size of each field assembly, mounting, and anchoring.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in FRP vessel manufacture similar to that indicated for this project and with a record of successful in-service performance in similar applications. Minimum experience of at least 10 installations with an installed service record of 5 years or greater is required.
- B. Installer Qualifications: Engage personnel experienced in FRP vessel installations similar to that required by this project who are acceptable to the FRP vessel manufacturers.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling and Unloading: Manufacturer shall provide shipping of all items specified to the project location. The Contractor shall make the Manufacturer fully responsible to adequately crate and protect all fiberglass items from damage during shipping. Damaged units may be rejected by Engineer and returned to the manufacturer for replacement or repair.
- B. Storage and Protection: Stored units shall be kept fully crated and protected from damage at all times prior to installation.

1.6 WARRANTY

- A. Warranties for materials and workmanship for all fiberglass equipment and accessories as specified in this section are to be valid for a period of not less than 3 years.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

- A. Acceptable Manufacturers for fiberglass tanks and their screens, standpipes and windows.
 - 1. Innovasea, Contact: (225) 755-0026,
 - 2. Reiff Manufacturing, Contact (509) 525-1081, Fax (509) 525 0439
- B. Description of Fiberglass Tanks
 - 1. Provide fiber-reinforced plastic tanks complete and ready for piping hookup and installation. The tanks are to be used for the production of fish in water temperatures ranging from 0 to 30 degrees Celsius. The tanks are to be used for interior application as shown on the Contract Drawings.
 - 2. Tanks shall conform to all dimensions and have the features indicated on the Contract Drawings. Contractor shall verify tank dimensions and resolve any spacing changes required prior to installation. All fish culture tanks shall be properly designed and built for stresses that may occur during fabrication, shipping, installation, and intermittent or continuous operation. All fish culture tanks shall have a continuous lip around the circumference of the tank to resolve hoop stresses and prevent expansion of the tanks when in operation.
 - 3. Tanks shall be supplied in a dark green.
 - 4. Tank standpipe openings and screen slots shall be fabricated for use as shown on the project plans.
 - 5. All tank screens shall be constructed of stainless steel and provided by the tank manufacturer. Screens shall be 1/8-inch thick perforated plate with 1/8-inch diameter holes, 40% minimum open area, and be interchangeable in any tank.
 - 6. All tank standpipes shall be provided by the tank manufacturer. Standpipes shall seat in receptacles where shown in the Contract Drawings to provide watertight seal at base.
 - 7. Exposed tank flange and interior surface shall receive high gloss gel coat finish with UV inhibitor.
- C. Extended Warranty
 - 1. The tanks shall be warranted in writing for a period of three (3) years from the date of substantial completion and acceptance. This date shall be confirmed in writing by the Engineer. The warranty shall include defective work, breakage, deformation, cracking, delamination, leakage and loss of finishes or fading of color.
- D. Fiberglass tanks shall be of the size and configuration shown on the Contract Drawings.

2.2 TANK MATERIALS

- A. The Contractor shall not install any material containing cadmium, brass, bronze, copper, zinc, or their alloys, which could come in contact with fish rearing water. These heavy metal materials have been shown to be toxic to fish.

B. Resin

1. The resin shall be US FDA-approved for use with foods and potable water. The resin, unless otherwise specified shall be as produced by Reichhold, Dow, Ashland or approved equal. The same resin shall be used throughout the laminate unless otherwise specified.
2. An isophthalic polyester resin, rated for use in fresh water applications at temperatures up to 65.6°C (150°F), shall be used for all FRP vessels, except where contact with ozone could occur when an ozone-resistant epoxy vinyl ester resin such as Derakane 411 by Ashland shall be used.
3. The resin used shall not contain fillers, unless specified. When specified up to 2% by weight thixotropic agent, Cab-O-Sil, or equal, may be used for viscosity control in the paraffinated top coat on vertical surfaces, provided it will not interfere with visual inspection.
4. Unless otherwise agreed upon by the manufacturer and the Engineer, the cure system used for the resin shall be in accordance with the resin manufacturer's current recommendations. Proper curing of the resin is the FRP vessel manufacturer's responsibility. All products fabricated to this specification shall be cured to at least 90% of the minimum Barcol Hardness specified by the resin manufacturer. This requirement applies to both interior and exterior surfaces. (Note: The use of paraffin in the resin or the use of synthetic veil may lower the Barcols below the resin manufacturer's specifications, this is acceptable.)
5. No chemical-resistant surface, interior or exterior, shall be acetone sensitive.

C. Reinforcement

1. Woven roving shall be Type E (electrical borosilicate) glass, nominal 24 oz./sq. yd., 4 by 5 weave, with a silane-type finish and a binder compatible with the lay-up resin.
2. Chopped strand mat shall be Type E glass, 1-1/2 oz. per sq. ft., with a silane finish and a styrene-soluble reactive binder.
3. Continuous roving used in chopper gun for spray-up shall be Type E.

D. Laminate Construction

1. The vessel shall be constructed using a multi-layered system consisting of, at minimum, the following layers:
 - a. Polyester gel coat
 - b. Chop strand fiberglass
 - c. Woven roving
 - d. Chop strand fiberglass
 - e. Polyester gel coat
2. The minimum thickness shall be 3/16 inches (4.763 mm).
3. The inner surface of each tank shall be smooth from a molded surface and consist of a polyester gel coat 15 to 18 mil thick and dark green in color. The exterior of each tank shall be finished with a polyester gel coat a minimum of 10 mil thick and dark green in color.
4. All factory perforations must be sealed with resin and gel coat. Field cut perforations may be sealed with epoxy or polyester resin and gel coat or with marine grade sealant.
5. A visual inspection of the laminate shall be made by the manufacturer. ASTM D2563 shall be used for quality control of construction. Laminate defects and the permissible limits shall be in accordance with the following table:

Defect	Process Surface	None Process Surface
Blisters	None	Max ¼ inch diameter, 0.0625 inch high
Burned Areas	None	None
Chips	None	Max ¼ inch with max thickness 20% of wall
Cracks	None	None
Crazing	None	Slight
Dry Spots	None	Max 2 sq. in./sq. ft.

Defect	Process Surface	None Process Surface
Entrapped Air	None at surface	0.125 inch diameter max; no more than 3% laminate, 0.0625 inch diameter of area, max 10/sq. in.
Exposed Glass	None	None
Exposed Cut Edges	None	None
Foreign Mater	None	None if it effects the properties of the laminate
Pits	Max 0.125 inch by 0.03125 inch deep, max 10/sq. ft.	Max 0.125 inch diameter by 0.0625 inch deep
Scratches	None (Coated)	None (Coated)
Surface Porosity	None	None
Wrinkles	Max deviation 20% of wall thickness	Max deviation 20% of wall thickness
Sharp Discontinuity	None	None

2.3 TANK COMPONENTS

A. Tank numbers and dimensional information will be required as noted below:

Number Required	Diameter (ft)	Depth (ft)	Features required
8	20	5	16" dia. Bottom center drain sump, side box combined with center drain, standpipe(s), spray bar. Provide a 36"x24" viewing window inside of all the tanks, see process floor plan for locations. Viewing windows to be flush with inside of tank.

- B. Fish exclusion screen shall be manufactured out of 1/8-inch thick 316 stainless steel, with 1/8-inch diameter perforations, and a minimum 40% open area.
- C. Tank bottom center drain sump may be constructed of FRP or PVC. It must include a fish escapement screen as noted on the Contract Drawings. The screen must be removable and securely fit into a recess around the interior of the Center Sump. The outlet sump shall be equipped with a side exit fitting as shown on the Contract Drawings.
- D. Sidewall tank outlet side box shall be constructed of FRP and incorporate a fish exclusion screen. The side box may be bolted in position by the Contractor during assembly. Box dimensions shall be as shown on the Drawings. The screen guide assembly shall be firmly secured to the tank or sidewall drain box all around the edges. The screen shall have handles and be able to be removed and replaced with another screen. Total open area of fish escapement screen shall be not less than 227 sq. inches for 20-foot tanks. The center drain will be integral with the side box drain as represented in the contract. The side box shall incorporate tank level control weir.
- E. Removable level control weirs and standpipes as shown on Contract Drawings shall be provided on tank side box and bottom drains as shown on the Contract Drawings.
- F. Provide mounting bracket to support belt feeder in each tank. Mounting bracket shall fasten to the inside of the tank wall.
- G. Use 316 stainless steel fasteners where required to assemble component pieces unless noted otherwise.

PART 3 - EXECUTION

3.1 GENERAL

- A. The manufacturer shall review and certify in writing that all installation requirements as shown on the Contract Drawings are in accordance with design character and limitations of the unit.
- B. The materials are to be covered and protected to prevent damage in shipment and handling. All finished surfaces are to be protected. Tanks shall not be stored in the open at manufacturer's site or at job site. Any damage to the units incurred in transit and unloading will be the responsibility of the manufacturer. Permits, import requirements, and precautionary measures required for highway transport are the entire responsibility of the manufacturer.
- C. The manufacturer shall be responsible for delivering and supervising the unloading of materials at the hatchery. Visually imperfect materials will be rejected. The manufacturer and Contractor shall fully cooperate in the inspection, unloading and installation of the units at the hatchery.
- D. The manufacturer shall fully cooperate and will assist the Contractor with respect to the tank inspection, shipping and loading/unloading schedule. The shipping schedule shall conform to the project completion schedule.
- E. The manufacturer must provide a qualified site representative with the first shipment of units to the project site to insure proper unloading, handling and final installation. The Contractor shall provide equipment to handle and install the tanks in strict accordance with the manufacturer's instructions.
- F. All minor defects must be refinished by the manufacturer prior to completion of the project and acceptance by the Engineer. The refinished surface shall show no discernible variations in appearance from the surrounding areas. The Contractor and manufacturer shall cooperate in this requirement; the intent is to provide high quality, identical rearing units. The Contractor must take all necessary precautions to protect the tanks during completion of this project.
- G. Prior to shipment, the tanks shall be cleaned to remove any residual parting agent, film or other deleterious material. The units shall be carefully cleaned (per the manufacturer's instructions) prior to completion of the project.
- H. The first tank manufactured shall be inspected by the Engineer at the manufacturing plant prior to shipment for conformance to Contract Drawings and Technical Specifications prior to manufacturing remaining order. All subsequent tanks shall be inspected by the Engineer prior to shipment to site.
- I. All fish culture tanks shall be properly designed and built for stresses that may occur during fabrication, shipping, installation, and intermittent or continuous operation. Workmanship shall be of high industrial standards in all respects.
- J. Surface Preparation: Clean and disinfect the fish culture tanks. Remove dirt and debris as work progresses.

3.2 INSTALLATION / CONSTRUCTION

- A. The fish culture tanks shall be installed according to the tank manufacturer's recommendations, including but not limited to:
- B. Over-excavate the tank site by at least 12 in. Where undisturbed native soil is not exposed, use a vibratory plate to compact to 95% standard proctor density (granular fill). Verify compaction. Prepare the ground using a minimum of 12 inches of sand. Compact the sand surface to 95% standard proctor density and slope to receive tank and verify compaction. When backfilling around the tank do not to put excess pressure on the outside of the tank. Maintain a water level greater than or equal to the backfill level so that the water pressure can counteract the pressure from the backfill during application. Backfill in maximum 12-inch lifts. Compact to 95% Proctor Density between lifts. Provide tank protection and expansion joint and caulk where the tank will meet concrete.

- C. The Fish Culture tank installation shall be coordinated with the process piping and other aquaculture equipment. Elevation of equipment should conform to the requirements of the engineer responsible for system hydraulics.
- D. The Center Sump, if not integral with the tank, shall be secured to the fish culture tank in the field using marine grade urethane sealant and stainless-steel anchor bolts, as appropriate to ensure a sturdy and water tight seal.

3.3 ADJUSTING

- A. Upon completion of the installation, the fish culture tanks shall be tested for satisfactory operation. All equipment shall be adjusted and checked for alignment, levelness, clearances, supports, and adherence to safety standards, until found satisfactory. This work will be performed by the Contractor
- B. The tank water level and flow in pipe systems is the responsibility of the engineer responsible for system hydraulics. Adjust standpipe lengths as specified by the engineer responsible for hydraulics to achieve target water level and flow rates.

3.4 DEMONSTRATION

- A. Test for leaks and defects in the fish culture tanks and parts of existing piping that have been altered, extended or repaired. Perform hydrostatic testing in accordance with manufacturer's instructions and test to design flow conditions. Repair leaks and defects with new materials and retest until satisfactory results are obtained.

END OF SECTION

SECTION 11 23 00
GAS MANAGEMENT TOWERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gas Management Towers.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. See Technical Specifications, Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. Operation and Maintenance Manuals:
 - 1. See Section 01 79 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Innovasea
 - 2. PR-Aqua (Pentair Aquatic Eco-Systems)
- B. Submit request for substitution in accordance with Section 01 33 00.

2.2 MATERIALS

- A. Gas Management Towers
 - 1. All gas balancing towers shall be provided by a single manufacturer. The manufacturer shall be a recognized manufacturer of gas management towers specifically for aquaculture and have at least 5 years' experience specific to the design and manufacture of gas management towers. A list of 4 installation references similar to these specifications shall be supplied along with other submittal materials.
 - 2. Gas Management Towers (GMT's)
 - a. GMT's shall be of the size and configuration shown on the Drawings.
 - b. The GMT's top dispersion plates shall have a minimum of 40% open area and openings sized to develop even distribution of water over the distribution plate and through the CO2 stripper.
 - c. GMT's shall have a minimum depth of 56" of structured media in the CO2 stripping portion of the tower.
 - d. GMT's must be able to operate with efficient water distribution and resist phase inversion at loading variances between 40 and 65 GPM per square foot. Design flow rate for 48"x48" GMT is 1040 GPM.
 - e. GMT's shall be constructed of FRP with UV inhibitor, and any distribution plates and/or covers shall be constructed of stainless steel type 304.
 - f. GMT's shall be designed to allow maintenance with towers in place. Removal of tower components through the backside of the unit is preferred.

PART 3 - EXECUTION

3.1 INSTALLATION OF GAS MANAGEMENT TOWERS

- A. Install in accordance with manufacturer's instructions.
- B. Handle GMT components with care so as to prevent damage to external shell, mounting flange, dispersion plates, etc.
- C. Ensure that GMT's are properly centered and adjustable leveling legs are set before bolts are tightened.

END OF SECTION



DIVISION 13

SPECIAL CONSTRUCTION



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SECTION 13 31 23

TENSIONED FABRIC STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Design, fabrication, and installation of replacement Tensioned Fabric Structures (Roof and Walls).
 - 2. Expected lifespan of new TFS structure: ± 15 years on fabric and 50 years on frame.
- B. Coordinate with work of other trades.
 - 1. All electric, lighting, and other utilities shall not be interrupted.
- C. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Division 05 - Metals.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
 - 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A500, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - c. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - d. A603, Standard Specification for Zinc-Coated Steel Structural Steel Wire Rope
 - e. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - f. F436, Standard Specification for Hardened Steel Washers.
 - g. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
 - 3. American Welding Society (AWS):
 - a. D1.1 Structural Welding Code Steel.
 - 4. National Fire Protection Association (NFPA):
 - a. 701, Test for Flame Propagation of Textiles and Films.
- B. Qualifications:
 - 1. Tensioned Fabric Structure (TFS) Manufacturer:
 - a. Responsible for design, engineering, fabrication, supply and installation of work specified herein.
 - b. Have been in 10 year continuous operation as a Tensioned Fabric Structure manufacturer of projects with similar size and scope.
 - 1) Provide references of a minimum of three previous projects within the past 10 years with similar applications (new or recover).
 - c. Provide onsite full-time Quality Assurance staff.
 - d. Engineer for TFS: Professional Engineer licensed in the State of.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer product data, including specifications and installation instructions for each component of the tensioned fabric structure.

2. Include laboratory test reports and other data, where applicable.
 3. Structural Calculations: Signed and sealed by engineer currently licensed to practice in State where project is located and specializing in TFS design and engineering. Structural calculations for fabric structure shall include:
 - a. Structural analysis of membrane system under applicable wind, seismic and snow loads.
 - b. Connection design including bolt, weld and ancillary member sizing.
 - c. Biaxial Fabric test specification.
- B. Shop Drawings:
1. Dimensioned and detailed drawings signed and sealed by licensed engineer:
 - a. Complete structure, including plan view, elevations, details, and sections,
 - b. Precise interface geometry determination,
 - c. Reaction loads,
 - d. Anchoring loads,
 - e. Connection details,
 - f. Interfaces and seam layouts.
 2. Full and comprehensive assembly procedure guide for installation.
- C. Samples: Provide three 12 IN square fabric swatches in color selected.
- D. Certifications:
1. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
 2. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
 3. Welder qualification data and prequalified procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store steel members and fabric above ground on skids and other supports.
1. Keep free of dirt and other foreign material and protect against corrosion.

1.5 WARRANTY

- A. Warrant all workmanship against defects for a period of one year, from date of substantial completion.
- B. Warrant all fabric materials supplied against defects for a period of ten years, from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Tensioned Fabric Structures:
1. Clearspan Fabric Structures International
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GENERAL:

- A. The purpose of this bid is for the purchase, delivery, and installation on site of a ClearSpan, or equal, 65' X 125' Tensioned Fabric Building, following the design specifications listed below.
- B. As equal manufacturer must be approved by addendum minimum of 7 days prior to bid opening.
- C. Building must be fabricated in the U.S.A. and be manufactured by 1 company with a minimum of 8 years documented experience manufacturing the specified building model under 1 business name.

- D. Manufacturers having an equal product may submit information to the Owner for inclusion in the approved list of manufacturers. Information shall demonstrate structures of similar size and shape, demonstrate materials and method of construction.
- E. Basis of Design: Clearspan Fabric Structures International, Inc. South Windsor, Ct
- F. **WA STATE ENGINEER STAMPED DRAWINGS ARE REQUIRED FOR THE BUILDING**
- G. Building to be installed on a helical pile foundation per included plans and drawings.
- H. The workmanship of all materials and components of the structure shall be commensurate with the functional requirements of the items.
- I. Building prefabrication shall be performed under factory conditions in a plant specifically arranged for this type of work. Contractor shall provide adequate space, equipment, personnel and technical ability to coordinate the assembly and factory prefabrication of all major components of the work and all necessary operation in the packing, shipping and installation procedures. No fabrication shall be done unless the materials have been tested and approved.

2.3 GENERAL DESIGN REQUIREMENTS:

- A. Warranty: 50-year on Frame & 10-year on Fabric.
- B. The membrane shall be tensioned over the framework.
- C. The structure shall be rectangular in shape with one end completely enclosed with (1) 48" 1HP slant wall exhaust fan on one end with a 36" by 80" walk-in door and a manual chain hoist 12x12 Duracoil rolling steel door.
- D. The opposite end will be completely enclosed with (2) 48" motorized louvers with a 36" by 80" walk-in door and a manual chain hoist 12x12 Duracoil rolling steel door.
- E. Fabric Termination shall be overlapping style.
- F. The interior of the structure below the main trusses shall be clear span free of any structural support members and shall provide unobstructed floor space.
- G. No exterior purlins, guy ropes or cables shall be used for anchoring the structures.
- H. Building to be engineered to 20 psf ground snow load and 105mph, ultimate wind speed.

2.4 DESIGN REQUIREMENTS-STRUCTURAL FRAME:

- A. Purlin Spacing: To provide for structural stability and to provide for installation of accessory items, the main structural trusses shall be laterally braced by tubular purlins at intervals required by the truss design.
- B. Wind and Frame Bracing: The structure shall be appropriately stabilized with wind bracing cable as well as any required secondary node restraint assemblies so as to efficiently transfer wind, snow and seismic induced stresses to the foundation/anchoring system. The end bays of the structure shall be designed to be X – braced early during installation to allow for permanent stability of the frames during installation.
- C. Connecting Joints: Connections between structural elements shall be designed so as to transfer the compressive and tensile forces present in a given joint. A minimum of Grade 5 bolts shall be used at each truss chord joint. Primary axial steel, secondary purlins and end wall frame connections shall be made with a minimum of Grade 5 hex bolts, carriage bolts and self-drilling screws.
- D. Mechanical Equipment Interface: The main structural roof trusses shall allow for installation of electrical and mechanical equipment based on collateral loads. Likewise, the structure shall accept penetrations through the membrane for access doors and mechanical services with minimal modification.

- E. All hardware needed to assemble buildings to be supplied by vendor / contractor.

2.5 DESIGN REQUIREMENTS – MEMBRANE CLADDING SYSTEM:

- A. Membrane: The roof membrane shall form a weather tight shell over the structural frame. In order to provide for a good finished appearance and to ensure weather tightness, the membrane shall be assembled and tensioned, in a manner to minimize wrinkles in hot and cold temperatures.
- B. The gable wall membrane cladding shall be manufactured and connected to form one piece to the adjacent end wall and roof cladding.
- C. Roof membrane horizontal stretch shall be maintained with horizontal purlins requiring no ongoing maintenance.
- D. Base Tensioning System: The membrane cladding will be provided with a mechanical tensioning system that allows the membrane to be fully tensioned around the structure perimeter. The system will be designed such that the membrane can be tightly and neatly secured over the structural frame and such that the system has remaining range of adjustment.
- E. Membrane Seal at Openings and Base: The Dealer supplying the structure will provide all materials and methods necessary to fully tension and seal the membrane material around all doors, ventilation and other opening as well as around the structure perimeter below the main tensioning system. This seal shall provide a neat and finished appearance and eliminate any loose membrane cladding that would otherwise be damaged by flapping or abrasion. When a membrane base skirt is required, this shall be supplied and attached at the base perimeter to allow a reasonable seal against air and water intrusion.
- F. The membrane shall not be designed to function as a structural member such that, should any damage to or penetrations of the membrane occur, the integrity of the structural framework shall not be affected.
- G. The Contractor shall provide drawings and calculations acceptable to the architect/Engineer of the Record, meeting the provisions of the applicable State Building Code. The Contractor shall bear all costs for production of drawings and associated structural calculations.
- H. Contractor shall make all revisions and corrections to those documents required for approval and shall resubmit as required to obtain approvals.

2.6 ENGINEERED DESIGN CRITERIA

- A. The structure shall be designed using methodology as per ASCE 7 standard referenced from the applicable building code. Primary and secondary framing shall comply with current issues of ISC, AISI, NEMA and ASTM specification, as applicable.

Structural members shall be designed using Allowable Stress Design (ASD) or Load Resistance Factored Design (LRFD) for the design loads given below. Wind load factors and coefficients used in design of structural members must be in accordance with the applicable ASCE 7 guidelines.
- B. Snow Loads: The structure shall be designed based upon a minimum ground snow load of 20 pounds per square foot (Psf).
- C. Wind Loads: The structure shall be capable of withstanding an ultimate wind speed (3-second gust) from any direction of 105 miles per hour. The design wind pressure shall be based on an exposure category of “C” and appropriate wind load factors and coefficients in accordance with the applicable referenced ASCE 7 guidelines. In no event shall the wind load used in the design of the main wind force resisting system be less than 10 pounds per square foot multiplied by the area of the building or structure projected on a vertical plane that is normal to the wind direction.
- D. Design Loads: The design shall be based as a minimum on the following design loads. Each member shall be designed to withstand stresses resulting from combinations of design loads that

produce maximum percentage of actual to allowable stress in that member as per referenced ASCE 7 standard from applicable building code.

D = Dead Load + Collateral Load
S = Symmetrical Snow or Live Load (Balanced or Unbalanced)
Ws = Wind with internal suction
Wp = Wind with internal pressure
E = Earthquake

2.7 OPERATION AND USE:

- A. The main structure frame shall be designed to provide a minimum of 50-year operational use period with appropriate inspection and maintenance. Owner's manual to be provided.
- B. The structure shall be capable of being assembled, operated and dismantled in all ambient temperatures between -20 °F and 120 °F.
- C. The structure shall be capable of being erected on concrete and of accepting differential settlement of up to 1 ½% between truss positions.

2.8 MATERIALS

- A. All materials used in the structure shall be new, without defects and free of repairs. The quality of the materials used shall be such that the structure is in conformance with the performance requirements specified herein.

1. Cladding Membrane: The structure shall be clad with a **flame retardant** polyolefin fabric manufactured by an approved and reputable supplier with demonstrated long-term performance. The polyolefin membrane fabric shall be waterproof and free from defects. All roofs, walls, end walls and connecting sections shall be weather tight.
2. The material shall be selected from the manufacturer's standard colors for the sidewalls and roof panels. The material scrim and coating must be UV stabilized and must carry a minimum 10-year manufacturer's warranty. The minimum fabric specification is as follows:

Total Fabric Weight	12.0 oz/yd ² (407 g/m ²) +/- 5%
Coating Thickness	4 mil average, each side
Finished Thickness	23 mils (ASTM D5199)
Grab Tensile Strength	355 lbs (ASTM D5034)
Strip Tensile Strength	270 lbs/in (ASTM D5035)
Tongue Tear Strength	115 lbs (ASTM D2261)
Trapezoidal Tear	95 lbs (ASTM D-4533)
Mullen Burst	675 psi (ASTM D3786)
Cold Crack Resistance	-60 °C (ASTM D2136)
UV Resistance & Weathering	>90% retention after 2000 hrs. ASTM G151

3. Metal: The main structure shall consist of welded truss arches with parallel tube chords separated apart by webbing. Parallel tube cords are made from triple coated, in-line galvanized structural steel tubing, cold-formed and induction welded of modified grade carbon steel, providing a finished tubular product with exceptional mechanical and corrosion resistant properties.
4. Tolerances: all dimensional tubing tolerances are in accordance with ASTM A500, Section 10.
5. Tubing shall be manufactured using steel conforming to ASTM A568 and ASTM A1011. Finished steel tubing used in the structure must have the following minimum structural and mechanical properties based on standard ASTM A500:

Tension Ultimate: 55 KSI and Yield: 50 KSI

6. Corrosion Protection: All steel tube components, trusses, purling, fastening tubes shall be coated, on the exterior, with a gloss finishing providing a corrosion resistance of 1800 hours as per ASTM B117-90;
7. 2 Coatings: Zinc conforms to ASTM B6, Standard Specifications for Zinc, High Grade (1.1.3.) and Special High Grade (1.1.2.).
 - a. Exterior: In-line galvanized to a normal coating zinc weight of 0.6 oz/ft². Chromate conversion coating applied over the galvanized surface to provide additional corrosion protection. Clear organic polymer applied as the top surface coat to retard oxidation, enhance surface appearance and provide a primer for subsequent painting or powder coating processes as desired.
 - b. Interior: Full zinc based organic coating applied to 100% of the interior surface as a corrosion barrier.

2.9 HARDWARE:

- A. Bolts: Bolts subject to extreme stress and wear shall be structural bolts of Grade 5 and plated/galvanized that has been upgraded with a corrosion resistant topcoat finish. All bolts shall be installed and securely torque so as the prevent change in tightness. Those subject to removal or adjustment shall not be swaged, peened, staked or otherwise installed.
- B. Membrane Tensioning Hardware: The fabric membrane shall be tensioned with load rated hardware. Hardware shall allow full and free rotation at the foundation connection to avoid fatigue of threaded assemblies.
- C. Membrane Tensioning Webbing: The membrane shall be tensioned with load-tested tie-downs.
- D. Cable Assemblies: Main and wind bracing cable assemblies shall be manufactured to the required length and press swaged with metal sleeves. The cables are manufactured using performed galvanized cables, sized with appropriate safety factors.

3/16" dia.	=	4,200 lbs.
1/4" dia.	=	7,000 lbs.
5/16" dia.	=	9,800 lbs.
3/8" dia.	=	14,400 lbs.
1/2" dia.	=	22,800 lbs.
- E. Other Fasteners: Non-structural fasteners such as wood screws, Tek screws, etc., shall be standard commercial quality.
- F. Exterior Trim: The aluminum alloy used in the extrusion shall meet or exceed 6063-T5.
- G. Piece marking and Identification: all individual parts or bundles and packages of identical parts are to be clearly marked for identification. Bolts, nuts, washers and fasteners shall be packaged according to type, size and length. Shipping documentation shall include a list showing the description, quantity and piece mark of the various parts, components and elements.
- H. Material Delivery: The building system materials shall be delivered to the project site during normal working hours on weekdays. (6:30am to 3:30pm). 24 hours advanced notice for delivery is required. Installation contractor will provide adequate workmen and equipment to promptly unload, inspect and accept material delivery.
- I. Handling: At no time shall materials be dropped, thrown or dragged over the transport equipment or the ground. Damage to any piece under its own or superimposed weight shall be cause for repair or replacement by the vendor or contractor.
- J. Short, damaged or excess materials: Installation contractor shall inspect, count and verify quantities based on the shipping documents.

PART 3 - EXECUTION

3.1 ERECTION

- A. Comply with manufacturer instructions, approved shop drawings and applicable building code requirements.
- B. Properly install all connections as per the Tensioned Fabric manufacturer's recommendations.
- C. Contractor to provide all materials and equipment required for the erection and stressing of the fabric.
- D. Unroll the fabric in such a manner as to avoid snagging or dragging the fabric over sharp objects during installation.
- E. The fabric structure manufacturer shall confirm adequate fabric prestress. The appearance of the fabric membrane roof shall be smooth and wrinkle free. Do not crease or fold the fabric around sharp corners.
- F. Cables shall be free of all kinks, crimps, and bends. Care shall be taken not to damage cables during installation.
- G. After installation, repair or replace marred or abraded surfaces to original condition using same paint or coating as factory-applied finishes.

END OF SECTION

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SECTION 13 34 19
METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Complete metal building system including but not limited to:
 - a. Design.
 - b. Materials.
 - c. Fabrication.
 - d. Shipment.
 - e. Erection.
 - f. Components as specified.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 07 42 13 – Preformed Metal Wall Panels.
 - 4. Section 07 61 13 – Metal Roofing.
 - 5. Section 07 92 00 - Joint Sealants.
 - 6. Section 08 11 00 - Hollow Metal Doors and Frames.
 - 7. Section 08 33 23 – Steel Rolling Overhead Doors.
 - 8. Section 08 41 10 – Storefront.
 - 9. Section 08 70 00 - Finish Hardware.
 - 10. Section 08 81 00 - Glass and Glazing.
 - 11. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Architectural Manufacturers Association (AAMA):
 - a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
 - 2. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - c. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - d. A792/A792M, Standard Specification for Steel Sheet, 55 PCT Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - e. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - f. C653, Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation.
 - g. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - h. C991, Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
 - i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - j. D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
 - k. D4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

- l. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- m. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
- n. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
- o. F436, Standard Specification for Hardened Steel Washers.
- p. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- q. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- r. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- 3. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code - Steel.
 - b. D1.3/D1.3M, Structural Welding Code - Sheet Steel.
- 4. FM Global (FM).
 - a. FMRC Standard 4471, Approval Standard for Class 1 Roofs for Hail Damage Resistance, Combustibility, and Wind Uplift Resistance.
- 5. International Accreditation Service (IAS):
 - a. AC472, Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems.
- 6. Metal Building Manufacturer's Association (MBMA):
 - a. Low Rise Building Systems Manual.
- 7. Research Council on Structural Connections (RCSC):
 - a. Specification for Structural Joints Using High-Strength Bolts.
- 8. The Society for Protective Coatings/NACE International (SSPC/NACE).
 - a. SP 6/NACE No. 3, Commercial Blast Cleaning.
- 9. Underwriters Laboratories, Inc. (UL):
 - a. Building Materials Directory.
- B. Qualifications:
 - 1. Manufacturer's qualifications:
 - a. Manufacturer must be member in good standing of the MBMA.
 - b. Manufacturer must be currently approved by IAS Accreditation Committed under the Inspection Programs for Manufacturers of Metal Buildings Systems IAS AC472 to assure compliance with fabrication Special Inspections as required by the building code.
 - 2. Erector qualifications:
 - a. Erector (installer) must be approved in writing by metal building manufacturer.
 - b. Erector must have minimum of 10 years current experience in erection of similar structures.
 - 3. Manufacturer's Structural Engineer: Registered in the State where project is located.

1.3 DEFINITIONS

- A. Code: The word "code" refers to the building code.
- B. Installer, Erector or Applicator:
 - 1. Installer, erector or applicator is the person actually installing, erecting or applying the product in the field at the Project site.
 - 2. Installer, erector and applicator are synonymous.
- C. PVDF: Polyvinylidene fluoride.
 - 1. Nomenclature as listed in Bibliography of the MBMA Low Rise Building Systems Manual.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's technical reference manual containing all of the manufacturer's standard construction details and specifications.
 - 1) Manufacturer's erection manual containing all details and methods for installation of building frame, roof system, wall system, and accessories.
 - 2) Edit to mark out items not used for this installation.
 - 3. Design and fabrication drawings:
 - a. Erection drawings minimum scale: 1/8 IN = 1 FT-0 IN.
 - b. Details and sections minimum scale: 1-1/2 IN = 1 FT-0 IN.
 - c. List of all design loads and combination of loads.
 - d. Size and location of each component of the building.
 - 1) Include clearance under structural framing members, both horizontal and vertical.
 - 2) Include cross-section of components.
 - e. Fasteners and details of fasteners connecting each component of the building.
 - f. Size, location and details of anchor bolts, base plates, and all other components fastened to the foundation.
 - 1) Size anchor bolts and base plates assuming 3000 PSI concrete.
 - g. Details of wall panels, roof panels, finishes, flashings, closures, closure strips, trim, gutters, downspouts, sealant, and all other miscellaneous components.
- B. Samples:
 - 1. Metal color and finish samples of roof and wall panels, roof trim, wall trim, and interior liner panel colors for Engineer's selection.
 - 2. Color chart is not acceptable.
- C. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- D. Informational Submittals:
 - 1. Manufacturer's and Erector's Qualifications.
 - 2. Manufacturer's approval of erector.
 - 3. Manufacturer's Certificate of Accreditation per IAS AC472.
 - 4. Structural calculations stamped and signed by a professional Structural Engineer licensed in the State where Project is located.
 - a. Include list of design loads and loads transmitted to foundation through columns or walls and location where loads occur.
 - b. Submit calculations for information only.
 - 5. Certificate of compliance by fabricator that steel was fabricated in accordance with the approved construction documents.

1.5 WARRANTY

- A. Manufacturer's standard warranty.
- B. Manufacturer's standard warranty for factory applied PVDF coating system against blistering, chipping, cracking, peeling, or color fading of wall and roof panels.
- C. Metal building system manufacturer shall provide a written weathertightness warranty for a maximum of 25 years against leaks in roof panels, arising out of or caused by ordinary wear and tear under normal weather and atmospheric conditions.

1. Warranty shall be signed by both the metal roof system manufacturer and the metal roof system installer.
 2. Maximum liability of warranty shall be no less than \$0.70/SQFT of roof area.
- D. Metal building system manufacturer shall provide a written warranty for 20 years against perforation of metal roof and wall panels due to corrosion under normal weather and atmospheric conditions.
1. Warranty shall be signed by metal roof system manufacturer.
 2. Acrylic Coated Galvalume: Product will not rupture, fail structurally, or perforate within period of 20 years due to normal atmospheric corrosion.
- E. Metal building system manufacturer shall provide a paint film written warranty for 25 years against cracking, peeling, chalking, and fading of exterior coating on painted roof and wall panels.
1. Warranty shall be signed by metal building system or roof system manufacturer and state that the coating contains 70 PCT "Kynar 500 IN or "Hynar 5000 IN resin.
 2. Failure of adhesion, peeling, checking, or cracking for 25 years.
 3. Color fading in excess of 5 Hunter units per ASTM D2244 for 25 years.
 4. Chalking in excess of No. 8 rating per ASTM D4214 for 25 years.
- F. Provide written notice of any exceptions taken to warranties.
1. Any exceptions may be grounds for not accepting the manufacturer, at the discretion of the Owner or Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metal building systems:
 - a. Butler Manufacturing.
 - b. NCI Building Systems.
 - c. Nucor Building Systems.
 - d. Star Building Systems.
 - e. Varco Pruden.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 SYSTEM DESCRIPTION

- A. Building shall be, with vertical walls and type roof.
1. Provide cross bracing in the side walls perpendicular to the rigid frame.
 2. Buildings with flush girts must have cast-in-place anchor bolts, due to minimum edge distance requirements for alternate anchor types.
- B. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of.

2.3 BUILDING DESIGN CRITERIA

- A. Critical Dimensions:
1. Building Size:
 - a. As indicated on the Drawings.
 2. Roof slope:
 - a. As indicated on the Drawings.
 3. Provide minimum clear inside dimensions as noted on the Drawings.
 4. Horizontal Plan Dimensions:
 - a. Measure to interior face of girts / outside face of rigid frame.
 5. Eave Height:

- a. Measure from top of finished floor to intersection of insides of roof and sidewall sheets.
- 6. Clear height between finished floor and bottom of roof steel: indicated on the drawings.
- B. Building Foundation:
 - 1. All footings, foundations, anchor bolts and piers have been designed based on assumed loadings and reactions.
 - a. Member sizes and geometry may vary depending on the building being supplied.
 - b. Do not construct these members until Engineer has verified design with approved Shop Drawings of metal building being supplied.
 - c. Design all column base plates as pinned connections. Fixed base plates are not permitted.
- C. Modifications:
 - 1. Buildings which vary dimensionally from those indicated may be bid providing:
 - a. Minimum interior horizontal dimensions and clear heights are maintained.
 - b. Door and window locations and sizes are maintained.
 - c. Foundation re-design and all construction costs are included in Bid.
 - 2. Building dimension changes in either horizontal or vertical direction resulting in either 5 PCT change of envelope volume or lighting height or spacing shall be addressed by incorporating any necessary changes to mechanical or electrical systems or any other building component impacted, at no additional cost to Owner.
 - a. Design changes must be approved by Engineer prior to constructing changed item or system.
 - b. Does not apply to structural member sizes.
 - 3. Contractor is responsible for incorporating any necessary changes to foundations, mechanical, or electrical systems or to any other building component.
 - a. Design changes must be approved by Engineer prior to constructing changed item or system.
 - 4. Itemize modifications in a separate attachment to the bid form and include all modifications in the bid price.
 - 5. Completed building to be free of excessive noise from wind induced vibrations under ordinary weather conditions to be encountered at location of erection, and meet all specified design requirements listed below.
- D. Roof Live Loads:
 - 1. Roof panels:
 - a. Per building code.
 - b. 50 PSF uniformly distributed live load.
 - c. 200 LB concentrated (point) live load (over a 1 x 1 FT area) located at center of maximum roofing (panel) span.
 - d. The most severe condition governs.
 - 2. Roof framing members:
 - a. Per building code.
 - b. Roof framing members do not need to be designed for 50 PSF uniform or 200 LB concentrated live loads.
 - 3. The above loads are in addition to other applicable equipment loads and shall be applied to the horizontal projection of the roof.
- E. Snow Loads:
 - 1. Design structure for snow loading as set forth in the building code.
 - a. Project site conditions are as follows:
 - 1) Basic ground snow: 20 PSF.
 - 2) Importance factor: 1.0.
 - 3) Snow exposure coefficient: 1.0.
 - 2. Design roof panels, secondary support members and primary framing where appropriate for a snow load drifting accumulation as specified in the building code.

- F. Wind Loads:
1. Design structure for wind loading as set forth in the building code.
 - a. Project site conditions are as follows:
 - 1) Basic wind speed: 110 MPH.
 - 2) Site exposure: Class C.
 - 3) Importance factor: 1.0.
 - 4) Enclosure type: .
- G. Seismic (Earthquake) Loads:
1. Design structure for seismic forces as set forth in the building code.
 - a. Project site conditions are as follows:
 - 1) Importance factor: 1.0.
 - 2) Spectral response acceleration (S_s): ____.
 - 3) Spectral response acceleration (S_1): ____.
 - 4) Site class: ____.
 - 5) Spectral response coefficient (S_d): ____.
 - 6) Spectral response coefficient (S_{d1}): ____.
 - 7) Seismic design category: D2.
- H. Auxiliary Loads:
1. Consider other superimposed loads as part of the design requirements and combine with the normal design (dead, live, seismic and wind) loads as prescribed hereafter.
 - a. Dynamic loads:
 - 1) ____ LBS.
 - b. Static loads:
 - 1) ____ PSF.
 - 2) ____ LBS for ____.
 - 3) ____ LBS for ____.
 - 4) ____ LBS for ____.
 - 5) ____ LBS for ____.
 - 6) ____ LBS for ____.
 2. Contractor to coordinate and verify magnitude and location of auxiliary loads before fabrication.
- I. Combination of Loads:
1. The combining of dead, live, wind, seismic and auxiliary loads for design purposes as set forth in the building code, unless otherwise specified.
 2. Horizontal sway deflection of building due to combination of required design loads:
 - a. ____ IN.
 3. Deflection of purlins and secondary members not to exceed $L/180$ of its span when supporting applicable vertical live, dead, and auxiliary loads.
 4. Wind beams supporting masonry walls: Do not deflect more than $L/240$ of its span when resisting applicable loads.
 5. Lintel beams supporting brick/masonry: Do not deflect more than the lesser of $L/600$ of span or 0.3 IN.

2.4 MATERIALS

- A. Steel:
1. Structural Shapes and Plate:
 - a. All W-shapes and WT-shapes: ASTM A992/A992M.
 - b. All other plates, bars and rolled shapes: ASTM A36/A36M.
 - c. Unless noted otherwise on Drawings.
 2. Miscellaneous Metals:
 - a. Insulation support: Structural Steel Grade 50 per ASTM C653.

- B. Bolts, Nuts and Washers, High Strength:
 - 1. Bolts: ASTM F3125, Grade A325.
 - 2. Nuts: ASTM A563.
 - 3. Washers (hardened): ASTM F436.
 - 4. Galvanized, ASTM A153/A153M.
 - 5. Provide two washers with all bolts.
- C. Bolts and Nuts:
 - 1. ASTM A307, Grade A.
 - 2. Galvanized, ASTM A153/A153M.
- D. Anchor Bolts:
 - 1. ASTM A307, ASTM A36/A36M, galvanized steel.
 - 2. Embedment details to be developed by Engineer upon receipt of anchor bolt and loading information for approved Shop Drawings from building manufacturer.
- E. Fasteners:
 - 1. Roof and wall panels: 300 series stainless steel, ASTM F593.
 - 2. Miscellaneous fasteners: Corrosion resistant.
- F. Any structural member to be hot-dipped galvanized shall be minimum 12 GA thickness.
- G. Roof Panels:
 - 1. See Specification Section 07 61 13.
 - 2. Wall Panels:
 - a. See Specification Section 07 42 13.
 - b.
 - 3. Wall and Roof Liner Panels and Soffit Panels:
- H. See Specification Section 07 42 13. Perimeter Trim, Panel Closures, Flashing and Counterflashing:
 - 1. Same material and factory applied finish to match roof and wall panels.
- I. Insulation:
- J. See Specification Sections 07 21 00 and 07 61 13.
- K. Vapor Retarder: ASTM C665.
- L. Gutters and Downspouts:
 - 1. See Specification Section 07 61 13.
- M. Grout: See Division 03.
- N. Closures: Neoprene.
- O. Calking and Sealants:
 - 1. See Specification Section 07 92 00.

2.5 FABRICATION

- A. General:
 - 1. Fabricate building structure, roof and wall panels, accessories and trim in accordance with requirements of AISC and MBMA.
 - 2. Provide all necessary clips, flashing angles, caps, channels, closures, bases and any other miscellaneous trim required for complete water and airtight installation.
 - a. Provide an inside closure at the base of all corrugated panels and an outside closure at the top of all corrugated panels in addition to all other closure strips required.
 - 1) Form closure strips to fit the corrugation of the metal panels and securely support in place.
 - 2) Closure strips shall fit between corrugated panels and trim or flashing as required to completely separate the interior of the building from the exterior.

- b. Provide flashing at all intersections of wall panels and roof panels, and above all openings in wall and roof panels, in addition to all other flashing required.
 - 1) Form flashing:
 - 2) To completely contain water on the outside of the building.
 - a) To be watertight and securely fastened in place.
 - c. Provide sealant at all edges where metal panel trim or flashing is adjacent to the foundation of the building in addition to all other sealant required.
 - 3. At door and window and louver openings, provide additional framing and fasteners as required to structurally replace the wall panel and/or framing displaced.
 - 4. Fabricate and prepare material for shipment knocked down.
 - 5. Factory punch frame to receive all fasteners.
 - 6. Finishes:
 - a. Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances.
 - 1) Clean all primary and secondary structural steel members, not noted as being galvanized, in accordance with SSPC SP 6/NACE No. 3.
 - b. All structural components shall have primer paint coats applied in the shop and finish coats applied in the field.
 - 1) Shop paint, prime and finish coats, all surfaces which will be inaccessible after erection.
 - 2) Paint in accordance with Specification Section 09 96 00.
 - 3) Paint surfaces of all components not exposed to view.
 - 4) Manufacturer's standard shop applied primer is not acceptable as substitute for primer specified.
 - c. Wall and roof panels:
 - 1) Exterior surface:
 - a) Thermosetting fluoropolymer resin enamel.
 - (1) Minimum 70 PCT "KYNAR" resin.
 - b) Meet requirements of AAMA 621.
 - c) FM Class 1 rated.
 - d) Exposed screw heads shall match color of panel.
 - 2) Interior surface:
 - a) Manufacturer's standard shop applied polyester coating.
- B. Structural Steel Design:
 - 1. Structural Mill Sections or Welded-up Plate Sections: Design in accordance with AISC Specification for Structural Steel Buildings.
 - 2. Cold-Formed Steel Structural Members: Design in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 3. Structural System: Design in accordance with specified building code (Refer to Design Loads and Building Codes).
- C. Primary Framing:
 - 1. Painted Steel.
 - 2. Rigid Frames:
 - a. Frames: Welded-up plate section columns and roof beams, complete with necessary splice plates for bolted field assembly.
 - b. Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes factory fabricated.
 - c. Columns and Roof Beams: Fabricated complete with holes in webs and flanges for attachment of secondary structural members and bracing.
 - d. Bolts for Field Assembly of Frame Members: High-strength bolts.
 - 3. Endwall Structural Members:
 - a. Cold-formed channel members designed in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members or welded-up

- plate sections designed in accordance with AISC Specification for Structural Steel Buildings.
- b. Endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.
- c. Splice Plates and Base Clips: Shop fabricated complete with bolt connection holes.
- d. Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes shop fabricated.
- e. Beams and Posts: Factory fabricated complete with holes for attachment of secondary structural members.
- 4. Intermediate Frames:
 - a. Substituted for end-wall roof beams, when specified.
 - b. Factory fabricate necessary endwall posts and holes for connection to intermediate frame used in endwall.
- D. Secondary Structural Members:
 - 1. Wall Purlins (Girts):
 - a. By-passing column purlins.
 - 2. Purlins:
 - a. Purlins:
 - 1) Zee-shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
 - 2) Zee sections to be design by manufacturer.
 - b. Eave Members:
 - 1) Eave Struts:
 - a) Cee-shapped precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
 - b) Factory punched cee sections to be design by manufacturer.
 - 2) Girts:
 - a) Zee or Cee shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
 - b) Zee or cee sections to be design by manufacturer.
 - 3) Outer Flange of Girts: Factory-punched holes for panel connections.
 - c. Bracing:
 - 1) Locate bracing as indicated on the Drawings.
 - 2) Diagonal Bracing:
 - a) Hot-rolled rods of sizes sections to be design by manufacturer.
 - b) Attach to columns and roof beams.
 - c) Optional fixed-base wind posts or pinned-base portal frames may be substituted for wall rod bracing on buildings as required.
 - 3) Flange Braces and Purlin Braces: Cold formed and installed as indicated on the Drawings.
- E. Welding:
 - 1. Welding Procedures, Operator Qualifications, and Welding Quality Standards:
 - a. AWS D1.1.
 - b. AWS D1.3.
 - 2. Welding inspection, other than visual inspection as defined by AWS D1.1, paragraph 6.9, shall be identified and negotiated before bidding.
 - 3. Certification of Welder Qualification: Supply when requested.
- F. Framed Openings:
 - 1. Walls:
 - a. Provide all necessary subframing, including connections, to support wall openings for doors, windows, louvers, pipe or duct penetrations, etc.
 - 1) Material gage to be determined by metal building manufacturer for size of opening.
 - b. Size and location of opening as shown on the Drawings.
 - c. Jamb, lintel and girts:

- 1) Steel:
 - a) Factory applied prime coat per Section 09 96 00.
 - 2) Metal building manufacturer responsible for providing correct size opening for penetration scheduled, shown or specified.
 - d. Provide trim to cover all exposed areas of opening frames to match with the wall panels.
 - 2. Roofs:
 - a. Provide all necessary roof subframing to support roof mounted equipment and to frame roof penetrations.
 - 1) Material gage to be determined by metal building manufacturer for size of equipment or opening.
 - b. Location of roof mounted equipment and/or roof or wall opening as shown on the Drawings.
 - c. Purlins, angles, clips:
 - 1) Steel:
 - a) Factory applied prime coat per Section 09 91 13.
 - 2) Metal building manufacturer responsible for providing correct size of opening for penetration scheduled, shown or specified.
- G. Painting of Structural Steel Framing System:
- 1. General:
 - a. Structural Steel: Prime paint as temporary protection against ordinary atmospheric conditions.
 - b. Perform subsequent finish painting, if required, in field as specified in the painting section.
 - c. Before painting, clean steel of loose rust, loose mill scale, dirt, and other foreign materials.
 - 2. Primary Frames:
 - a. Clean steel in accordance with SSPC SP 2.
 - b. Factory cover steel with 1 coat of gray water-reducible alkyd primer paint formulated to equal or exceed performance requirements SSPC-Paint 15.
 - c. Minimum Coating Thickness: 1.0 MIL.
 - 3. Secondary Structural Members – Roll-Formed:
 - a. Hot-dipped zinc coating, ASTM A653, G30; followed by 1 coat of clear acrylic finish.
 - b. Acrylic-Coated G30 Galvanized Steel: Equal or exceed performance requirements of SSPC Paint-15.

2.6 ROOF PANEL SYSTEM

A. Metal Roof Panel System:

2.7 METAL WALL PANEL SYSTEM

A. Metal Wall Panels:

- 1. See Specification Section 08 42 13.

2.8 BUILDING INSULATION SYSTEMS

- 1. See Specification Section 07 61 13.
 - a. 6 IN (R-19).

2.9 ACCESSORIES

A. Interior Wall Liner Panel:

- 1. See Specification Section 07 42 13.
- 2. Color:

B. Soffit Panel:

- 1. See Specification Section 07 61 13.

C. Overhead Doors:

1. See Specification Section 08 33 23.
- D. Metal Pedestrian Doors and Frames:
 1. See Specification Section 08 11 00.
- E. Windows:
 1. See Specification Section 08 41 10.
- F. Louvers:
 1. See Specification Section 08 90 00.
- G. Gutters and Downspouts:
 1. See Specification Section 07 61 13 and Section 07 62 00.
 - a. Profiles based on SMACNA Architectural Sheet Metal Manual.
- H. Roof Penetration Flashing (Maximum 13 IN DIA):
 1. Flashing material: EPDM rubber with an aluminum sealing ring base.
 2. Minimum projection above the weather surface of the roof: 8 IN.
 3. Configuration of the flanges to match the roof panel.
- I. Specification Section for manufacturer's internal quality control requirements.
- J. Testing:
 1. Owner may employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
 2. Independent testing agency shall have a minimum of five (5) years performing similar work and shall be subject to Owner's approval.

2.10 MAINTENANCE MATERIALS

- A. Provide 8 OZ of touch up paint for each color provided on the building.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
 1. Install tolerances in accordance with AISC 303, Code of Standard Practice.
 - a. Install products straight without bowing, sagging, or warping.
 2. Install all fasteners.
 3. Install base plates on grout bed.
 - a. Grout bed to be 1 IN thick unless noted otherwise on the Drawings.

3.2 INSTALLATION – METAL ROOF SYSTEM

- A. Metal Roof System Installation:
 1. Install roof system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 2. Install roof system weathertight.
 3. Position panel clips by matching hole in clip with factory-punched holes in secondary structural members.
 4. Position and properly align panels by matching factory-punched holes in panel end with factory-punched holes in eave structural member and by aligning panel with panel clip.
 5. Field seam panel side laps by self-propelled and portable electrical lock-seaming machine.
 - a. Machine field forms the final 180 DEG of a 360-degree Pittsburgh double-lock standing seam.
 - b. Factory apply side lap sealant.
 6. Panel End Laps: Minimum of 6 IN, sealed with sealant (weather sealing compound), and fastened together by clamping plates.
 - a. Sealants: Contain hard nylon beads, which prevent mastic from flowing out due to clamping actions.

- b. Join panel laps by 2-piece clamped connection consisting of a bottom reinforcing plate and a top panel strap.
 - c. Locate panel end laps directly over, but not fastened to, supporting secondary roof structural member and stagger, to avoid 4-panel lap-splice condition.
- 7. Minimum Blanket Insulation Thickness: 2 IN.
- B. Metal Roof System Installation:
 - 1. Install roof system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install roof system weathertight.
 - 3. Attach roof panels to supporting structural members with seamed-in-clip device.
 - a. Install clip at panel major corrugation.
 - 4. Design roof panel side laps to be interlocking seams with return leg on lower edge of female rib.
 - a. Factory apply side lap sealant.
 - 5. Roof Panel End Laps:
 - a. Minimum of 6 IN.
 - b. Seal with field-applied sealant.
 - c. Swage 1 panel end to ensure nestible, watertight end laps.
 - d. Install backing plate directly over, but not fastened to, structural support members.
 - e. Self-Drilling Fasteners: Do not use to make panel end splices.
- C. Metal Roof System Installation:
 - 1. Install roof system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install roof system weathertight.
 - 3. Factory cut-to-length roof panels in accordance with erection drawings furnished by metal building system manufacturer.
 - 4. Position and align roof panels to hold 3 FT module throughout building length.
 - a. Position and align optional factory-punched roof panels by matching factory-punched holes in panels with factory-punched holes in roof structural members.
 - 5. Install side laps with minimum of 1 full corrugation.
 - 6. End Laps:
 - a. Minimum of 6 IN.
 - b. Fasten together over and to structural members.
 - 7. Panel Side and End Laps: Seal with "Panlastic" sealant to prevent entry of capillary moisture.

3.3 INSTALLATION – METAL WALL SYSTEM

- A. Metal Wall System Installation:
 - 1. Install wall system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install wall system weathertight.
 - 3. Verify structural system is plumb before wall panels are attached.
 - 4. Seal wall panels with molded-foam closure block that fits panel configuration at top and bottom of wall panels.
 - 5. Exterior Trim: Match exterior color and embossing of wall panel system.
 - 6. Interior Trim: Painted.
 - 7. Flashings, Trim, Closures, and Similar Items: Install as indicated on erection drawings furnished by metal building system manufacturer.
- B. Metal Wall System Installation:
 - 1. Install wall system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install wall system weathertight.
 - 3. Verify structural system is plumb before wall panels are attached.

4. Align and attach wall panels in accordance with erection drawings furnished by metal building system manufacturer.
5. Install side laps with minimum of one full corrugation.
6. Seal wall panels at base with metal trim.
7. Windows: Factory paint aluminum extrusions (thermally broken).
8. Flashings, Trim, Closures, and Similar Items: Install as indicated on erection drawings furnished by metal building system manufacturer.

3.4 INSTALLATION – OTHER ITEMS

- A. Insulation Installation: Install insulation in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
- B. Place roof insulation over roof support members.
 1. Tape all joints and tears in vapor barrier with tape recommended by vapor barrier manufacturer.
- C. Place wall insulation between girts and wall panels.
 1. Tape all joints and tears in vapor barrier with tape recommended by vapor barrier manufacturer.
- D. Separate the roof support member from the roof panel, except at each concealed structural fastener, with a spacer of material having a density of not less than 2 PCF and, if of a combustible material, having a flame spread rating no greater than 25.
- E. Fasten roof panels to purlins or secondary support members in accordance with manufacturer's recommendations.
- F. Install liner panels in accordance with manufacturer's recommendations.
 1. Completely seal air tight around all building structural members and bracing when these members penetrate the liner panel.
- G. Insulation Support System Installation:
 1. Install insulation support system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 2. Verify roof structural system is in place before installation of insulation support system.
 3. Keep insulation support system in place after metal roof system is installed.
- H. Install wall panels to supporting structure with concealed fasteners.
 1. Finish of fasteners to match panel finish.
- I. Install door frames, window frames, louvers, trim and other miscellaneous items in accordance with manufacturer's instructions and details.

3.5 FIELD QUALITY CONTROL

- A. All inspections and tests are to be performed at the Project site by a third party independent testing agency.
- B. Inspect field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
 1. Visually inspect all welds.
 2. Test 50 PCT of full penetration welds and 10 PCT of fillet welds with liquid dye penetrant.
 3. Test 20 PCT of full penetration welds with ultrasonic or radiographic testing.
- C. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints, Section 9.
 1. Inspect while work is in progress.
- D. Inspect structural steel which has been erected.
- E. Prepare and submit test reports to Engineer.

3.6 ADJUSTING AND CLEANING

- A. See Specification Section 01 75 00 for Adjusting requirements.
- B. See Specification Section 01 74 23 for Cleaning requirements.
- C. Touch up paint any scratched factory finished surfaces or remove and replace as directed by Engineer.
- D. Remove and replace any damaged wall or roof panels, frames, etc., as directed by Engineer.

END OF SECTION



DIVISION 23

HEATING, VENTILATING, AND AIR
CONDITIONING (HVAC)



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SECTION 23 80 00
HVAC - EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Heating, ventilating, and cooling equipment.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 - a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
 - b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
 - c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - 2. Canadian Standards Association (CSA).
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 5. National Roofing Contractors Association (NRCA).
- B. Miscellaneous:
 - 1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
 - 2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Fabrication and/or layout drawings.
 - 3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Wiring diagrams.
 - d. Control diagrams.
 - e. Manufacturer's catalog cuts and technical data.
 - f. Corrosion-protection information.
 - g. Fan curves.
 - h. Sound data.
 - i. Vibration isolation.
 - j. Control description.
 - k. Performance data on all equipment.
 - 4. Certifications:
 - a. Provide certification of thickness of corrosion-protection coating.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:

- a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Convector heaters - electric:
 - a. Indecco
 - 2. Radiant Heaters – electric:
 - a. Indecco
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GENERAL

- A. All Manufactured Units:
 - 1. Factory wired and assembled.
 - 2. Use fasteners made of same material as unit.
 - 3. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
 - a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.
- B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
 - 1. Type:
 - a. Corrosion-resistant materials:
 - 1) Aluminum.
 - 2) Stainless steel.
 - b. Corrosion-resistant coating:
 - 1) Phenolic-based coating:
 - a) 3 MIL minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DEGF.
 - b) 5 MIL baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DEGF.
 - c) Factory applied.
 - d) Provide factory certification of application.

2.3 MANUFACTURED UNITS

- A. Unit Heater - Electric:
 - 1. UL listed for non-rated areas.
 - 2. Material:
 - a. Cabinet: 18 GA steel.
 - b. Heating elements: Copper-clad steel.
 - 3. Fan motors:
 - a. Built-in automatic reset overload protection.
 - 4. Dynamically balanced fan.
 - 5. Built-in automatic reset cutout protection.
 - 6. Accessories:
 - a. Mounting bracket.
 - b. 40 to 90 DEGF, 5 DEGF differential wall-mounted thermostat.
 - 7. Electrical, fan motor, and airflow data as scheduled on Drawings.
 - 8. Refer to equipment schedule for additional requirements.
- B. Ceiling Mounted Unit Heater - Electric:
 - 1. UL listed
 - 2. Fan forced

3. Designed for ceiling surface, recess or T-bar mounting.
 4. 80/20 NiCh resistance wire enclosed in a steel sheath to which plate fins are copper brazed.
 5. Fan shall be five bladed aluminum. Fan motor shall be totally enclosed.
 6. Thermal cutout shall be built into the system.
 7. Disconnect shall be mounted on the 20 gauge galvanized steel back box.
 8. Refer to equipment schedule for additional requirements.
- C. Convector Heaters - Electric:
1. Sloped top cabinet. Heavy gauge galvanized steel painted with beige powder coat.
 2. Linear limit, automatic reset thermal cutout
 3. Iridite-coated elements and powder coated frames
 4. UL listed.
 5. Grade A nickel chromium heating coils, copper heater tube and fitted with large aluminum fins.
 6. Explosion proof rated for class 1, div. 2.
 7. Size and capacity as scheduled on Drawings.
 8. Refer to equipment schedule for additional requirements
- D. Radiant Heaters – Electric:
1. 95% efficiency.
 2. Black Satin
 3. Flat panel IR emitter.
 4. UL rated for outdoor use under cover.
 5. Rear mounted junction box.
 6. Provide electric units with backbox, insulation, heating element, radiant face and mounting configuration.
 7. Surface: Front panel shall be coated using a product as recommended by manufacturer.
 8. Element: Graphite based with uniform temperature distribution over entire panel surface.
 9. Refer to equipment schedule for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment as recommended by manufacturer and as specified.
- B. Support equipment in compliance with SMACNA and building codes.
- C. Maintain heater clearances to combustibles as shown on manufacturer's installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Comply with Specification Section 23 05 93.

3.3 ADJUSTING

- A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

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DIVISION 26

ELECTRICAL



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SECTION 26 05 00
ELECTRICAL - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for electrical systems.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Division 03 - Concrete.
 - 4. Section 01 61 03 - Equipment - Basic Requirements.
 - 5. Section 03 15 19 - Anchorage to Concrete.
 - 6. Section 10 14 00 - Identification Devices.
 - 7. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
 - 8. Section 26 05 33 - Raceways and Boxes.
 - 9. Section 26 05 48 - Seismic Bracing Systems.
 - 10. Section 40 41 13 - Heat Tracing Cable

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Aluminum Association (AA):
 - a. ADM, Aluminum Design Manual.
 - 2. American Institute of Steel Construction (AISC):
 - a. Steel Construction Manual.
 - 3. American National Standards Institute (ANSI).
 - 4. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C2, National Electrical Safety Code (NESC).
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 7. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 6, Industrial Control and Systems Enclosures.
 - 8. Underwriters Laboratories, Inc. (UL).
- B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
 - 1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
 - 2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 INTENT

- A. The Contractor is responsible for providing a complete and operating facility. The intention of the Contract Documents is to include all labor and materials, equipment, and transportation necessary or reasonably inferable as being necessary for the execution of the work. By submitting a proposal, the Contractor represents that he has made a thorough examination of the site, of the work and existing conditions and limitations, and that he has examined the Contract Documents in complete detail and has determined beyond doubt that the drawings, specifications and existing conditions are sufficient, adequate, and satisfactory for the construction of the work under the Contract. Where minor adjustments of the work are necessary for purposes of fabrication or installation of items, or resolution of conflicts between items within the intent of the Contract Documents, the Contractor shall make such adjustments at no added expense to the Owner. Where such adjustments affect functional or aesthetic design of the work, they shall first be submitted to the Owner's Representative for review and approval. Indiscriminate changes of design by the Contractor are not acceptable.
- B. Discrepancies: Bring to the Owner Representative's attention any discrepancies within the Contract Documents or between the Contract Documents and field conditions, and any design and layout changes required due to specific equipment selection, etc., prior to equipment and material purchasing and installation. Corrective work necessitated by discrepancies after purchasing and installation shall be at the Contractor's expense.

1.4 DRAWINGS

- A. The electrical drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the electrical system. Provide all related electrical work which is specified herein, diagrammed or scheduled on the electrical drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electrical systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings.
- B. Branch Circuit Wiring:
 - 1. Duplex receptacles and miscellaneous power wiring are shown diagrammatically. In general, the panel and circuit numbers are shown adjacent to the device or equipment connection.
 - a. Branch circuits shall be 2#12 & 1#12 GND IN 3/4"C, unless shown otherwise in the Drawings.
 - 2. Provide all conduit, wire, and junction boxes in accordance with all applicable code and standards.

1.5 DEFINITIONS

- A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
 - 1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
 - 2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
 - 3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
 - 4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

B. Definitions:

Provide	Furnish and install
As Directed	As directed by the Owner's Representative
As Shown	As shown on the drawings
Concealed	Built into the construction and not exposed to view
Hot-Dip Galvanized	Galvanized after fabrication by hot-dip process
Per	According to; in accordance with
Engineer	Engineer responsible for electrical contract documents

C. Abbreviations:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ETL	Electrical Testing Laboratories
FM	Factory Mutual
IBC	International Building Code (2009 edition)
IEEE	Institute of Electrical and Electronics Engineers
IMC	International Mechanical Code
IPC	International Plumbing Code
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
UL	Underwriters Laboratories, Inc.

1.6 CODES AND STANDARDS

- A. Comply with the National Electrical Code, NFPA regulations, and all other applicable national, state, and local codes and ordinances.
- B. Workmanship shall comply with NECA "Standard of Installation."

1.7 SAFETY AND PROTECTION

- A. Safety Measures to Be Taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site. It shall be the Contractor's responsibility to comply with "Safety and Health Regulations for Construction," Volume 36, No. 75, Part II of the Federal Register by the U.S. Department of Labor. Contractor shall be responsible for providing all such safety measures and shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether he is or is not in compliance with state or federal regulations.

1.8 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of submittal process.

2. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
3. General requirements:
 - a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
 - b. Include data sheets that include manufacturer's name and product model number.
 - 1) Clearly identify all optional accessories.
 - c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
 - d. Manufacturer's delivery, storage, handling and installation instructions.
 - e. Product installation details.
 - f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
 - g. See individual specification sections for any additional requirements.
4. Fabrication and/or layout drawings:
 - a. Concrete and reinforcing steel, per Division 03 requirements.
- B. Operation and Maintenance Manuals:
 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content process of Operation and Maintenance Manuals.
- C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

1.9 SYSTEM DESCRIPTION

- A. Provide functioning systems in compliance with National Electrical Code, manufacturer's instruction, performance requirements specified or shown in the Contract Documents, and modifications resulting from reviewed shop drawings and field coordinated drawings.
- B. Provide power and control wiring to HVAC equipment (such as supply fans, exhaust fans, unit heaters, chillers, boiler, air handling units, Field Equipment Controllers, etc.) as shown in the electrical drawings. Provide local equipment disconnects. Provide local control stations as shown on control diagrams and as required by the HVAC control system.
- C. Provide complete power distribution systems including raceways, wiring, and power supply to all equipment shown. Includes design of required raceways and wiring where only the electrical device is in the Contract Documents.
- D. Provide complete interior lighting system including all lighting equipment, raceways, wiring, and switching equipment:
 1. Includes design of required raceways and wiring.
 2. Only the fixtures, circuits, and switching schemes are shown in the Contract Documents.
 3. Fixture locations are approximate and shall be field adjusted as practical to avoid interferences with piping, cable tray, HVAC equipment, ductwork, etc.
- E. Provide complete exterior lighting system including all lights, building exterior lighting equipment, and switching equipment:
 1. Includes design of required raceways and wiring.
 2. Only the fixtures, circuits, and switching schemes are shown in the Contract Documents.
 3. For each exterior light, provide a switch located inside near the associated door (or the nearest exterior door) that enables two operation modes: off or auto control by photocell. Provide photocell. Provide appropriate labels for switch.
 4. For each exterior, surface-mounted light near a canopy, install the fixture under the canopy, sheltered from weather and drips. Similarly located receptacles shall be similarly located and protected.

- F. Site duct banks penetrate structure walls in various locations on the Contract Drawings. Coordinate these penetrations with other construction disciplines and submit a sketch for review of each duct bank penetration. Submit for review prior to construction.
- G. The proposed utility transformer, proposed standby generator, proposed switchboard shall all have the same power system bus phase rotation. The Contractor shall provide a written phase rotation testing plan for review, prior to pulling in and terminating any major multiple conductors per phase feeder. Major feeders on this project consist of multiple large conductors per phase. Phase rotation confirmation shall be field verified prior to termination of major feeder conductors.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. See Specification Section 01 65 50.
- B. Protect nameplates on electrical equipment to prevent defacing.

1.11 AREA DESIGNATIONS

- A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types and materials of conduits, mounting hardware materials, electrical equipment support system material, wiring devices and installation methods to be used in that area.
 - 1. See Material Application Schedule below for acceptable materials for areas with the given designations.
- B. The Drawings indicate the area environmental designation and classification for each area or room of the project. Reference the Designation with the Material Application Schedule below to determine appropriate materials.
 - 1. For areas not defined on the Drawings, provide materials in accordance with the “Wet, Corrosive Areas” designation of the Material Application Schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.
- C. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

- A. Electrical Equipment Support Pedestals and/or Racks:
 - 1. Manufacturers:
 - a. Modular strut:
 - 1) Unistrut Building Systems.
 - 2) B-Line by Eaton.
 - 3) Globe Strut.
 - 4) Superstrut by Thomas & Betts.
 - 2. Material requirements:
 - a. Modular strut:
 - 1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
 - 2) Stainless steel: AISI Type 316.
 - 3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.
 - 4) Aluminum: AA Type 6063-T6.
 - b. Structural members (e.g., I beams, L and C channels):
 - 1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.

- 2) Aluminum: AA Type 6061-T6 or 6063-T6.
 - c. Mounting plates:
 - 1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
 - 2) Aluminum: AA Type 6063-T6.
 - d. Mounting hardware:
 - 1) Galvanized steel.
 - 2) Stainless steel.
 - e. Anchorage per Specification Section 03 15 19.
 - f. Concrete and reinforcing steel: See Division 03 specifications.
- B. Equipment pads (interior and exterior):
 - 1. Concrete and reinforcing steel: See Division 03 specifications.
 - C. Field touch-up of galvanized surfaces.
 - 1. Zinc-rich primer.
 - a. One coat, 3.0 MILS, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.
- B. Install equipment in accordance with the requirements of:
 - 1. NFPA 70.
 - 2. IEEE C2.
 - 3. The manufacturer's instructions.
- C. In general, conduit routing is not shown on the Drawings.
 - 1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
 - 2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.
- D. When complete branch circuiting is not shown on the Drawings:
 - 1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
 - 2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
 - 3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
 - 4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.
- E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.
- F. Install equipment plumb, square and true with construction features and securely fastened.
- G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.
- H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.
- I. Device Mounting Schedule:

1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
 - a. Light switch (to center): 46 IN.
 - b. Receptacle in architecturally finished areas (to center): 18 IN.
 - c. Receptacle on exterior wall of building (to center): 18 IN.
 - d. Receptacle in non-architecturally finished areas (to center): 46 IN.
 - e. Telephone outlet in architecturally finished areas (to center): 18 IN.
 - f. Telephone outlet for wall-mounted phone (to center): 46 IN.
 - g. Safety switch (to center of operating handle): 54 IN.
 - h. Separately mounted motor starter (to center of operating handle): 54 IN.
 - i. Pushbutton or selector switch control station (to center): 46 IN.
 - j. Panelboard (to top): 72 IN.
- J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
 1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 6 IN in equipment location with the Engineer's approval.
- K. Provide electrical equipment support system per the area environmental designation and classification and Material Application Schedule.
- L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
 1. See Specification Section 05 50 00.
 2. Do not cut, or weld to, building structural members.
 3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.
- M. Provide non-metallic corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.
- N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.
- O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.
- P. Do not use materials that may cause the walls or roof of a building to discolor or rust.
- Q. Identify electrical equipment and components in accordance with Specification Section 10 14 00.
- R. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.
- S. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 1. Determine the SCCR rating by one of the following methods:
 - a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.

3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

3.2 FIELD QUALITY CONTROL

- A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
 1. See Specification Section 01 73 20 for openings and penetrations in structures.
- B. Replace equipment and systems found inoperative or defective and re-test.
- C. The protective coating integrity of support structures and equipment enclosures shall be maintained.
 1. Repair galvanized components utilizing a zinc rich paint.
 2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
 3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
 4. Repair surfaces which will be inaccessible after installation prior to installation.
 5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.
- D. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

- A. Demonstrate equipment in accordance with Specification Section 01 75 00.

3.4 MATERIAL APPLICATION SCHEDULE

- A. Material Application Schedule:

Area Designation	NEMA 250 Enclosure Type (including Pull and Junction Boxes)	Conduit Material	Outlet and Device Boxes, Mounting Plates, and Fittings	Mounting Hardware and Support System	Notes
Wet, Corrosive Area	Type 4X, metallic	PVC-Coated RGS	PVC-coated cast metal, 304 stainless steel	316 Stainless Steel	
Hazardous and Corrosive Area	Type 7 and 4X, suitable for classification	PVC-Coated RGS	PVC-coated cast metal, 304 stainless steel	316 Stainless Steel	
Wet, Indoors Area	Type 4	RGS	Cast Metal	316 Stainless Steel	
Dry Industrial Area	Type 12	RGS	Cast Metal	Galvanized	
Dry, Indoors, Unfinished Area	Type 12	RGS	Cast Metal	Galvanized	Route conduit concealed where noted
Dry, Indoors, Finished Area	Type 1	EMT	Sheet Metal	Galvanized	Route conduit concealed
Exterior Area	Type 3R	RGS	Cast Metal	316 Stainless Steel	

Area Designation	NEMA 250 Enclosure Type (including Pull and Junction Boxes)	Conduit Material	Outlet and Device Boxes, Mounting Plates, and Fittings	Mounting Hardware and Support System	Notes
Exterior and Corrosive Area	Type 4X	RGS	Cast Metal	316 Stainless Steel	
Underground, Underslab, or Concrete Encased	N/A	PVC or Fiberglass	N/A	N/A	

END OF SECTION

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SECTION 26 05 19
WIRE AND CABLE - 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Building wire.
 - b. Power cable.
 - c. Control cable.
 - d. Shielded VFD cable.
 - e. MC cable.
 - f. Instrumentation cable.
 - g. Wire connectors.
 - h. Insulating tape.
 - i. Pulling lubricant.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Insulated Cable Engineers Association (ICEA):
 - a. S-58-679, Standard for Control Cable Conductor Identification.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. ICS 4, Industrial Control and Systems: Terminal Blocks.
 - 3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
 - a. WC 57/S-73-532, Standard for Control Cables.
 - b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
 - 5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
 - a. 568, Commercial Building Telecommunications Cabling Standard.
 - 6. Underwriters Laboratories, Inc. (UL):
 - a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
 - b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
 - c. 467, Standard for Safety Grounding and Bonding Equipment.
 - d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
 - e. 486C, Standard for Safety Splicing Wire Connections.
 - f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
 - g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

- i. 2225, Cables and Cable Fittings for Use in Hazardous (Classified) Locations.
- j. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

- A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
- B. Instrumentation Cable:
 - 1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
 - 2. The following are specific types of instrumentation cables:
 - a. Analog signal cable:
 - 1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
 - 2) Commonly used types are defined in the following:
 - a) TSP: Twisted shielded pair.
 - b) TST: Twisted shielded triad.
 - b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.
- C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.
- D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.
- E. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.
- F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
 - 1) Wire connectors.
 - 2) Insulating tape.
 - 3) Cable lubricant.
 - b. See Specification Section 26 05 00 for additional requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Building wire, power and control cable:
 - a. Aetna Insulated Wire.
 - b. Alphawire.
 - c. Cerrowire.
 - d. Encore Wire Corporation.
 - e. General Cable.
 - f. Okonite Company.

- g. Southwire Company.
- 2. Shielded VFD cable:
 - a. Belden Inc.
 - b. General Cable.
 - c. Okonite Company.
 - d. Olfex Wire and Cable, Inc.
 - e. Priority Wire and Cable (Prysmian).
 - f. Rockbestos-Surprenant Cable Corp.
 - g. Southwire Company.
- 3. Instrumentation cable:
 - a. Analog cable:
 - 1) Alphawire.
 - 2) Belden Inc.
 - 3) General Cable.
- 4. Wire connectors:
 - a. Burndy Corporation.
 - b. Buchanan.
 - c. Ideal.
 - d. Ilsco.
 - e. 3M Co.
 - f. Teledyne Penn Union.
 - g. Thomas and Betts.
 - h. Phoenix Contact.
- 5. Insulating and color coding tape:
 - a. 3M Co.
 - b. Plymouth Bishop Tapes.
 - c. Red Seal Electric Co.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

- A. Building Wire:
 - 1. Conductor shall be copper with 600 V rated insulation.
 - 2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
 - 3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 - 4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
 - 5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.
- B. Power Cable:
 - 1. Conductor shall be copper with 600 V rated insulation.
 - 2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 - 3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
 - 4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
 - 5. Number of conductors as required, including a bare ground conductor.
 - 6. Individual conductor color coding:
 - a. ICEA S-58-679, Method 4.
 - b. See PART 3 of this Specification Section for additional requirements.
 - 7. Conform to NFPA 70 Type TC.
- C. Control Cable:
 - 1. Conductor shall be copper with 600 V rated insulation.

2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
 4. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
 5. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
 - a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
 6. Individual conductor color coding:
 - a. ICEA S-58-679, Method 1, Table E-2.
 - b. See PART 3 of this Specification Section for additional requirements.
 7. Conform to NFPA 70 Type TC.
- D. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
 2. Conductors shall be stranded.
 3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 4. Conform to UL 44 for Type SIS insulation.
 5. Conform to UL 83 for Type MTW insulation.
- E.
1. Sheath: Galvanized steel interlocked armor.
 2. Conductors: Building wire as specified herein.
 3. Quantity and size of conductors: As indicated on the Drawings, including a ground wire.
 4. Individual conductor color coding as specified in PART 3 of this Specification Section.
 5. Conform to NFPA 70 Type MC, UL 1569.
- A. Shielded VFD Cable:
1. Conductor shall be copper, stranded with 600 V rated insulation.
 2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 3. Design and Fabrication:
 - a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
 - b. Shielding: 5 MIL copper tape, longitudinally applied with a minimum overlap of 15%.
 - c. Number of conductors: 3 PH and 3 equally spaced ground conductors.
 4. Individual conductor color coding:
 - a. ICEA S-58-679, Method 4.
 - b. See PART 3 of this Specification Section for additional requirements.
 5. When installed exposed outdoors, UL listed and marked as sunlight resistant.
 6. For continuously corrugated cable, use manufacturer approved fittings.
 7. Conform to NFPA 70, Type TC.
- B. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 2. Analog cable:
 - a. Tinned copper conductors.
 - b. 600 V PVC insulation with PVC jacket.
 - c. Twisted with 100 PCT foil shield coverage with drain wire.
 - d. Six (6) twists per foot minimum.
 - e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
 - f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.

C. Voice Only, Premise Backbone Cable

1. Category 3 (16MHz), DIW 25-Pair, U/UTP-Unshielded, Riser CMR.
 2. 24AWG solid bare copper conductors, nonbonded-pair cable
 3. PVC insulation, Ripcord, PVC jacket.
- D. Wire Connectors:
1. Twist/screw on type:
 - a. Insulated pressure or spring type solderless connector.
 - b. 600 V rated.
 - c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
 - d. Phase and neutral conductors: Conform to UL 486C.
 2. Compression and mechanical screw type:
 - a. 600 V rated.
 - b. Ground conductors: Conform to UL 467.
 - c. Phase and neutral conductors: Conform to UL 486A.
 3. Terminal block type:
 - a. High density, screw-post barrier-type with white center marker strip.
 - b. 600 V and ampere rating as required, for power circuits.
 - c. 600 V, 20 ampere rated for control circuits.
 - d. 300 V, 15 ampere rated for instrumentation circuits.
 - e. Conform to NEMA ICS 4 and UL 486A.
- E. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
 2. Premium grade.
 3. Heat, cold, moisture, and sunlight resistant.
 4. Thickness, depending on use conditions: 7, 8.5, or 10 MIL.
 5. For cold weather or outdoor location, tape must also be all-weather.
 6. Color:
 - a. Insulating tape: Black.
 - b. Color coding tape: Fade-resistant color as specified herein.
 7. Comply with UL 510.
- F. Electrical Equipment Enclosure and Cable Sealing Bushing:
1. Galvanized malleable or ductile iron.
 2. Zinc electroplated locknut.
 3. Neoprene sealing ring.
- G. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Permitted Usage of Insulation Types:
1. Type XHHW-2:
 - a. Building wire and power and control cable in architectural and non-architectural finished areas.
 - b. Building wire and power and control cable in conduit in outdoor areas and below grade.
 - c. Building wire and power and control cable in cable tray in outdoor areas.
 2. Type THHN/THWN and THHN/THWN-2:
 - a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.
 3. Type SIS and MTW:
 - a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. MC Cable:

1. Within stud framed walls of architecturally finished areas.
2. Above acoustical tile ceiling of architecturally finished areas.

C. Conductor Size Limitations:

1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:

1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

- a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
 - b. Conductors larger than No. 6 AWG:
 - 1) Insulated phase and neutral conductors shall be identified by one of the following methods:
 - a) Continuous colored outer finish along its entire length.
 - b) 3 IN of colored tape applied at the termination.
 - 2) Insulated grounding conductor shall be identified by one of the following methods:
 - a) Continuous green outer finish along its entire length.
 - b) Stripping the insulation from the entire exposed length.
 - c) Using green tape to cover the entire exposed length.
 - 3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.
2. Power cables ICEA S-58-679, Method 4 with:
 - a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
 - b. Ground conductor: Bare.
 3. Control cables ICEA S-58-679, Method 1, Table E-2:
 - a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
 - b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
- E. Install all wiring in raceway unless otherwise indicated on the Drawings.
- F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.
 2. Where field conditions dictate and written permission is obtained from the Engineer.

3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
 - a. The combinations shall comply with the following:
 - 1) 12 VDC, 24 VDC and 48 VDC may be combined.
 - 2) 125 VDC shall be isolated from all other AC and DC circuits.
 - 3) AC control circuits shall be isolated from all DC circuits.
 4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
 - a. The combinations shall comply with the following:
 - 1) Analog signal circuits may be combined.
 - 2) Digital signal circuits may be combined but isolated from analog signal circuits.
 5. Multiple branch circuits for similar loads may be combined in a common raceway, such as multiple lighting circuits or multiple receptacle circuits or other 120Vac circuits. Do not combine lighting and receptacle circuits.
 - a. Do not combine control device circuits with lighting or receptacle circuits.
 - b. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
 - 1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
 - 2) The neutral conductors may not be shared.
 - 3) Up sizing raceway size for the size and quantity of conductors.
- G. Ground the drain wire of shielded instrumentation cables at one end only.
1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).
- H. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
1. Feeder and branch power circuits:
 - a. Device outlet boxes:
 - 1) Twist/screw on type connectors.
 - b. Junction and pull boxes and wireways:
 - 1) Twist/screw on type connectors for use on No. 8 and smaller wire.
 - 2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
 - c. Motor terminal boxes:
 - 1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
 - 2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
 - d. Manholes or handholes:
 - 1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
 - 2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
 2. Control circuits:
 - a. Junction and pull boxes: Terminal block type connector.
 - b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
 - c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
 3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
 - a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
 - b. Junction and pull boxes: Terminal block type connector.
 - c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.
- I. Insulating Tape Usage:
 1. For insulating connections of No. 8 AWG wire and smaller: 7 MIL vinyl tape.
 2. For insulating splices and taps of No. 6 AWG wire or larger: 10 MIL vinyl tape.
 3. For insulating connections made in cold weather or in outdoor locations: 8.5 MIL, all weather vinyl tape.
- J. Color Coding Tape Usage: For color coding of conductors.

3.2 FIELD QUALITY CONTROL

- A. Acceptance Testing:
 1. See Specification Section 26 08 13.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for grounding and bonding system(s).
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.
 - 4. Section 26 05 00 - Electrical - Basic Requirements.
 - 5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
 - 6. Section 26 05 33 - Raceways and Boxes.
 - 7. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
 - 3. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 4. Society of Cable Telecommunications Engineers (SCTE):
 - a. 77, Specification for Underground Enclosure Integrity.
 - 5. Underwriters Laboratories, Inc. (UL):
 - a. 467, Grounding and Bonding Equipment.
- B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
 - 1) Grounding clamps, terminals and connectors.
 - 2) Exothermic welding system.
 - b. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Ground rods and bars and grounding clamps, connectors and terminals:
 - a. ERICO by Pentair.
 - b. Harger Lightning & Grounding.

- c. Heary Bros. Lightning Protection Co. Inc.
- d. Burndy by Hubbell.
- e. Robbins Lightning, Inc.
- f. Blackburn by Thomas & Betts.
- g. Thompson Lightning Protection, Inc.
- 2. Exothermic weld connections:
 - a. ERICO by Pentair - Cadweld.
 - b. Harger Lightning & Grounding - Ultraweld.
 - c. Burndy by Hubbell - Thermoweld.
 - d. FurseWELD by Thomas & Betts.
- 3. Prefabricated composite test stations:
 - a. Armorcast Products Company.
 - b. MacLean Highline.
 - c. Quazite by Hubbell

2.2 COMPONENTS

- A. Wire and Cable:
 - 1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
 - 2. Insulated conductors: Color coded green, per Specification Section 26 05 19.
- B. Conduit: As specified in Specification Section 26 05 33.
- C. Ground Bars:
 - 1. Solid copper:
 - a. 1/4 IN thick.
 - b. 2 or 4 IN wide.
 - c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
 - 2. Predrilled grounding lug mounting holes.
 - 3. Stainless steel or galvanized steel mounting brackets.
 - 4. Insulated standoffs.
- D. Ground Rods:
 - 1. 3/4 IN x 10 FT.
 - 2. Copper-clad:
 - a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
 - b. Corrosion resistant bond between the copper and steel.
 - c. Hard drawn for a scar-resistant surface.
- E. Grounding Clamps, Connectors and Terminals:
 - 1. Mechanical type:
 - a. Standards: UL 467.
 - b. High copper alloy content.
 - 2. Compression type for interior locations:
 - a. Standards: UL 467.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Terminals for connection to bus bars shall have two bolt holes.
 - 3. Compression type suitable for direct burial in earth or concrete:
 - a. Standards: UL 467, IEEE 837.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Factory filled with oxide inhibiting compound.
- F. Exothermic Weld Connections:
 - 1. Copper oxide reduction by aluminum process.
 - 2. Molds properly sized for each application.

- G. Prefabricated Composite Material Test Stations:
1. Body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
 2. Minimum load ratings: SCTE 77 Tier 15.
 3. Open bottom.
 4. Stackable design as required for 3 FT depth.
 5. Cover:
 - a. Engraved legend of "GROUND".
 - b. Lay-in non-bolt down.
 6. Size: 12 IN round or 12 IN square.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
1. Install products in accordance with manufacturer's instructions.
 2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
 3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
 4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01 73 20.
 - a. Seal the sleeve interior to stop water penetration.
 5. Do not splice grounding electrode conductors except at ground rods.
 6. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and conductors.
 - b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
 - c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
 - d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
 - e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
 7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.
- B. Grounding Electrode System:
1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
 - a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.
 2. Grounding electrode conductor terminations:
 - a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
 - b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
 - c. Piping systems: Use mechanical type connections.
 - d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
 - e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
 - f. Ground rod: Compression type or exothermic weld, unless otherwise specified.

- g. At all above grade terminations, the conductors shall be labeled per Specification Section 10 14 00.
- 3. Ground ring grounding system:
 - a. Ground ring consists of ground rods and a conductor looped around the structure.
 - b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
 - c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
 - d. Building/Structure grounding:
 - 1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
 - e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
 - f. Ground rod test stations:
 - 1) Provided where indicated on the Drawings.
 - 2) Grounding conductors connected to ground rod with removable ground clamps.
- 4. Triad grounding system:
 - a. Triad consists of three ground rods arranged in a triangle separated by 20 FT and a conductor interconnecting each ground rod.
 - b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
 - c. Grounding conductor: Bare conductor, size as indicated on the Drawings.
- C. Supplemental Grounding Electrode:
 - 1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
 - a. See Grounding Electrode System paragraph for conductor termination requirements.
 - 2. Metal light poles:
 - a. Connect metal pole and pole base reinforcing steel to a ground rod.
 - b. Grounding conductor: Bare #6 AWG minimum.
 - 3. Equipment support rack and pedestals mounted outdoors:
 - a. Connect metallic structure to a ground rod.
 - b. Grounding conductor: #6 AWG minimum.
 - 4. Engine generator:
 - a. Connect generator frame to the ground ring at two locations (opposite corners of frame).
 - b. Grounding conductor: Bare conductor, size as indicated on the Drawings.
 - 5. Ground cranes and hoists in accordance with NFPA 70, Article 610.
 - 6. Ground elevators in accordance with NFPA 70, Article 620.
- D. Transformer Separately Derived Grounding System:
 - 1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
 - 2. Structures with a single electrical room/area:
 - a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.
 - 3. Structures with multiple electrical rooms/areas:
 - a. Provide a ground bar mounted in each electrical room/area.
 - b. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar as indicated on the Drawings.
 - c. Connect grounding electrode conductor to the electrical room/area ground bar.
 - 4. See Grounding Electrode System paragraph for conductor termination requirements.
- E. Telecommunications Grounding System:
 - 1. Coil 5 FT of insulated #6 AWG conductor at each telephone terminal board and mechanically connected to the ground bar or to the service entrance electrical equipment.
 - 2. Grounding bar: Mounted on or adjacent to telephone terminal board.

- a. Grounding conductor: Bare conductor, size as indicated on the Drawings.
- F. Raceway Bonding/Grounding:
 - 1. Install all metallic raceway so that it is electrically continuous.
 - 2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
 - 3. NFPA 70 required grounding bushings shall be of the insulating type.
 - 4. Provide double locknuts at all panels.
 - 5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
 - 6. Provide bonding jumpers if conduits are installed in concentric knockouts.
 - 7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.
- G. Equipment Grounding:
 - 1. Ground all utilization equipment with an equipment grounding conductor.
- H. Manhole and Handhole Grounding:
 - 1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
 - a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
 - 2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.
- I. Prefabricated Composite Material Test Station:
 - 1. Place test station on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
 - 2. Provide concrete encasement ring around test station per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).

3.2 FIELD QUALITY CONTROL

- A. Leave grounding system uncovered until observed by Owner.
- B. Acceptance testing:
 - 1. See Specification Section 26 08 13.
- C. Provide a continuity test on the components of the grounding electrode system.
- D. Complete grounding system: Resistance of 5 ohms or less.
- E. Test resistance of installed ground system after backfilling and before connection to any other grounded system including underground piping, utility services or other building ground systems.
 - 1. Test ground grid resistance by fall-of-potential method.
 - 2. Perform test at the ground rod test station.

END OF SECTION

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SECTION 26 05 33

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Conduits.
 - b. Conduit fittings.
 - c. Conduit supports.
 - d. Wireways.
 - e. Outlet boxes.
 - f. Pull and junction boxes.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 43 - Electrical - Exterior Underground.
 - 5. Section 26 27 26 - Wiring Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Aluminum Association (AA).
 - 2. American Iron and Steel Institute (AISI).
 - 3. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - e. TC 14.AG, Aboveground Reinforced Thermosetting Resin Conduit and Fittings.
 - f. TC 14.BG, Belowground Reinforced Thermosetting Resin Conduit and Fittings.
 - 5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. C80.1, Electric Rigid Steel Conduit (ERSC).
 - b. C80.3, Steel Electrical Metallic Tubing (EMT).
 - c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 7. Underwriters Laboratories, Inc. (UL):
 - a. 1, Standard for Flexible Metal Conduit.
 - b. 6, Electrical Rigid Metal Conduit - Steel.
 - c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - d. 360, Standard for Liquid-Tight Flexible Metal Conduit.
 - e. 467, Grounding and Bonding Equipment.

- f. 514A, Metallic Outlet Boxes.
- g. 514B, Conduit, Tubing, and Cable Fittings.
- h. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- i. 797, Electrical Metallic Tubing - Steel.
- j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
- k. 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
- l. 2420, Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- m. 2515, Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
 - 1) Conduit fittings.
 - 2) Support systems.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Rigid metal conduits and electrical metallic tubing:
 - a. Allied Tube and Conduit.
 - b. Western Tube and Conduit Corporation.
 - c. Wheatland Tube.
 - d. Patriot Aluminum Products, LLC.
 - 2. PVC coated rigid metal conduits:
 - a. Ocal by Thomas & Betts.
 - b. Robroy Industries.
 - 3. Rigid nonmetallic conduit:
 - a. Prime Conduit.
 - b. Cantex, Inc.
 - c. Osburn Associates, Inc.
 - d. Champion Fiberglass, Inc.
 - e. United Fiberglass of America, Inc.
 - 4. Flexible conduit:
 - a. AFC Cable Systems.
 - b. Anamet, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Company.
 - e. Southwire Company, LLC.
 - 5. Wireway:
 - a. Hoffman Engineering.
 - b. Wiegmann by Hubbell.
 - c. Square D by Schneider Electric.

6. Conduit fittings and accessories:
 - a. Appleton by Emerson Electric Co.
 - b. Carlon by Thomas & Betts.
 - c. Cantex, Inc.
 - d. Crouse-Hinds by Eaton.
 - e. Killark by Hubbell.
 - f. Osburn Associates, Inc.
 - g. O-Z/Gedney by Emerson Electric Co.
 - h. Raco by Hubbell.
 - i. Steel City by Thomas & Betts.
 - j. Thomas & Betts.
7. Support systems:
 - a. Unistrut by Atkore International, Inc.
 - b. B-Line by Eaton.
 - c. Kindorf by Thomas & Betts.
 - d. Minerallac Company.
 - e. CADDY by Pentair.
 - f. Superstrut by Thomas & Betts.
8. Outlet, pull and junction boxes:
 - a. Appleton by Emerson Electric Co.
 - b. Crouse-Hinds by Eaton
 - c. Killark by Hubbell.
 - d. O-Z/Gedney by Emerson Electric Co.
 - e. Steel City by Thomas & Betts.
 - f. Raco by Hubbell
 - g. Bell by Hubbell.
 - h. Hoffman Engineering.
 - i. Wiegmann by Hubbell.
 - j. B-Line by Eaton.
 - k. Adalet.
 - l. RITTAL North America LLC.
 - m. Stahlin by Robroy Enclosures.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 RIGID METAL CONDUITS

- A. Rigid Galvanized Steel Conduit (RGS):
 1. Mild steel with continuous welded seam.
 2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
 3. Threads galvanized after cutting.
 4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
 5. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6.
- B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
 1. Nominal 40 MIL Polyvinyl Chloride Exterior Coating:
 - a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
 - b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
 2. Nominal 2 mil, minimum, urethane interior coating.
 3. Urethane coating on threads.
 4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
 5. Female Ends:
 - a. Have a plastic sleeve extending a minimum of one pipe diameter or 2 IN, whichever is less beyond the opening.

- b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
- 6. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6, NEMA RN 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Mild steel with continuous welded seam.
- B. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
- C. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
- D. Standards: NFPA 70 Type EMT, NEMA/ANSI C80.3, UL 797.

2.4 RIGID NONMETALLIC CONDUIT

- A. Schedules 40 (PVC-40) and 80 (PVC-80):
 - 1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
 - 2. Rated for direct sunlight exposure.
 - 3. Fire retardant and low smoke emission.
 - 4. Shall be suitable for use with 90 DEGC wire and shall be marked "maximum 90 DEGC".
 - 5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.
- B. Fiberglass:
 - 1. Epoxy based resin system using an anhydride curing agent.
 - 2. Continuous E-glass roving.
 - 3. Winding angle approximately 54.75 DEG.
 - 4. Smooth internal walls with all fibers imbedded in the epoxy.
 - 5. Above grade rated: Halogen free additive for flame spread and smoke control.
 - 6. Ultraviolet inhibitor: Carbon black.
 - 7. Two-step curing process.
 - 8. Tensile strength: 11,000 PSI per ASTM D2105.
 - 9. Dimensions: Iron Pipe Size (IPS).
 - 10. Wall thickness:
 - a. Standard: 3/4 IN to 4 IN nominal size.
 - b. Medium: 5 IN to 6 IN nominal size.
 - c. Extra Heavy for "bullet proof" and Class 1, Division 2 areas: 3/4 IN to 6 IN nominal size.
 - 11. Integral bell and spigot.
 - 12. Conduits and fittings to be joined with an interference joint and epoxy adhesive creating a concrete and water tight connection.
 - 13. Standard: NFPA 70 Type RTRC, NEMA TC14.AG, NEMA TC14.BG, UL 2420, UL 2415.

2.5 FLEXIBLE CONDUIT

- A. Flexible Galvanized Steel Conduit (FLEX):
 - 1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
 - 2. Standard: NFPA 70 Type FMC, UL 1.
- B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
 - 1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
 - 2. Extruded PVC outer jacket positively locked to the steel core.
 - 3. Liquid and vaportight.
 - 4. Standard: NFPA 70 Type LFMC, UL 360.

2.6 WIREWAY

- A. General:
 - 1. Suitable for lay-in conductors.

2. Designed for continuous grounding.
 3. Covers:
 - a. Hinged or removable in accessible areas.
 - b. Non-removable when passing through partitions.
 4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
 5. Standards: UL 870, NEMA 250.
- B. General Purpose (NEMA 1 rated) Wireway:
1. 14 or 16 gage steel without knockouts.
 2. Cover: Solid, non-gasketed and held in place by captive screws.
- C. Watertight (NEMA 4X rated) Wireway:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
 2. Cover: Fully gasketed and held in place with captive clamp type latches.
 3. Flanges: Fully gasketed and bolted.
- D. Dusttight (NEMA 12 rated) Wireway:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
 2. Cover: Fully gasketed and held in place with captive clamp type latches.
 3. Flanges: Fully gasketed and bolted.

2.7 CONDUIT FITTINGS AND ACCESSORIES

- A. Fittings for Use with RGS:
1. General:
 - a. In hazardous locations listed for use in Class I, Groups C and D locations.
 2. Locknuts:
 - a. Threaded steel or malleable iron.
 - b. Gasketed or non-gasketed.
 - c. Grounding or non-grounding type.
 3. Bushings:
 - a. Threaded, insulated metallic.
 - b. Grounding or non-grounding type.
 4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
 5. Couplings:
 - a. Threaded straight type: Same material and finish as the conduit with which they are used on.
 - b. Threadless type: Gland compression or self-threading type, concrete tight.
 6. Unions: Threaded galvanized steel or zinc plated malleable iron.
 7. Conduit bodies (ells and tees):
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. Cover:
 - 1) Clip-on type with stainless steel screws.
 - 2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
 8. Conduit bodies (round):
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
 9. Sealing fittings:
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. With or without drain and breather.
 - d. Fiber and sealing compound: UL listed for use with the sealing fitting.

10. Hazardous location flexible coupling (HAZ-FLEX):
 - a. Liquid tight and arc resistant.
 - b. Electrically conductive so no bonding jumper is required.
 - c. Dry and wet areas:
 - 1) Bronze braided covering over flexible brass core.
 - 2) Bronze end fittings.
 - 3) Zinc-plated steel or malleable iron unions and nipples.
 - d. Corrosive areas:
 - 1) Stainless steel braided covering over flexible stainless steel core.
 - 2) Stainless steel end fittings.
 - 3) Aluminum unions and nipples.
 11. Service entrance head:
 - a. Malleable iron, galvanized steel or copper free aluminum.
 - b. Insulated knockout cover for use with a variety of sizes and number of conductors.
 12. Expansion couplings:
 - a. 2 IN nominal straight-line conduit movement in either direction.
 - b. Galvanized steel with insulated bushing.
 - c. Gasketed for wet locations.
 - d. Internally or externally grounded.
 13. Expansion/deflection couplings:
 - a. 3/4 IN nominal straight-line conduit movement in either direction.
 - b. 30 DEG nominal deflection from the normal in all directions.
 - c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
 - d. Internally or externally grounded.
 - e. Watertight, raintight and concrete tight.
 14. Standards: UL 467, UL 514B, UL 1203.
- B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."
- C. Fittings for Use with EMT:
1. Connectors:
 - a. Straight, angle and offset types furnished with locknuts.
 - b. Zinc plated steel.
 - c. Insulated gland compression type.
 - d. Concrete and raintight.
 2. Couplings:
 - a. Zinc plated steel.
 - b. Gland compression type.
 - c. Concrete and raintight.
 3. Conduit bodies (ells and tees):
 - a. Body: Copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. Cover:
 - 1) Screw down type with steel screws.
 - 2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
 4. Standard: UL 514B.
- D. Fittings for Use with FLEX:
1. Connector:
 - a. Zinc plated malleable iron.
 - b. Squeeze or clamp-type.
 2. Standard: UL 514B.

- E. Fittings for Use with FLEX-LT:
 - 1. Connector:
 - a. Straight or angle type.
 - b. Metal construction, insulated and gasketed.
 - c. Composed of locknut, grounding ferrule and gland compression nut.
 - d. Liquid tight.
 - 2. Standards: UL 467, UL 514B.
- F. Fittings for Use with Rigid Nonmetallic PVC Conduit:
 - 1. Coupling, adapters and conduit bodies:
 - a. Same material, thickness, and construction as the conduits with which they are used.
 - b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
 - c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
 - 2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
 - 3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.
- G. Fittings for Use with Rigid Nonmetallic Fiberglass Conduit:
 - 1. Coupling and adapters shall be of the same material, thickness, and construction as the conduit.
 - 2. Epoxy adhesive for joining conduits and fittings shall be supplied by the same manufacturer as the conduit and fittings and shall provide a concrete and water tight connection.
 - 3. Standard: NFPA 70 Type RTRC, NEMA TC14.AG, NEMA TC14.BG, UL 2420, UL 2415.
- H. Weather and Corrosion Protection Tape:
 - 1. PVC based tape, 10 mils thick.
 - 2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
 - 3. Used with appropriate pipe primer.

2.8 ALL RACEWAY AND FITTINGS

- A. Mark Products:
 - 1. Identify the nominal trade size on the product.
 - 2. Stamp with the name or trademark of the manufacturer.

2.9 OUTLET BOXES

- A. Metallic Outlet Boxes:
 - 1. Hot-dip galvanized steel.
 - 2. Conduit knockouts and grounding pigtail.
 - 3. Styles:
 - a. 2 IN x 3 IN rectangle.
 - b. 4 IN square.
 - c. 4 IN octagon.
 - d. Masonry/tile.
 - 4. Accessories:
 - a. Flat blank cover plates.
 - b. Barriers.
 - c. Extension, plaster or tile rings.
 - d. Box supporting brackets in stud walls.
 - e. Adjustable bar hangers.
 - 5. Standards: NEMA/ANSI OS 1, UL 514A.
- B. Cast Outlet Boxes:
 - 1. Zinc plated cast iron or die-cast copper free aluminum with manufacturer's standard finish.
 - 2. Threaded hubs and grounding screw.
 - 3. Styles:
 - a. "FS" or "FD".

- b. "Bell".
- c. Single or multiple gang and tandem.
- d. "EDS" or "EFS" for hazardous locations.
- 4. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.
- 5. Standards: UL 514A, UL 1203.

C. See Specification Section 26 27 26 for wiring devices, wallplates and coverplates.

2.10 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:

- 1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
- 2. With or without concentric knockouts on four sides.
- 3. Flat cover fastened with screws.

B. NEMA 4 Rated:

- 1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
- 2. Seams continuously welded and ground smooth.
- 3. No knockouts.
- 4. External mounting flanges.
- 5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
- 6. Cover with oil resistant gasket.

C. NEMA 4X Rated (metallic):

- 1. Body and cover: 14 GA Type 304 or 316 stainless steel.
- 2. Seams continuously welded and ground smooth.
- 3. No knockouts.
- 4. External mounting flanges.
- 5. Hinged door and stainless steel screws and clamps.
- 6. Door with oil-resistant gasket.

D. NEMA 7 and NEMA 9 Rated:

- 1. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
- 2. Drilled and tapped openings or tapered threaded hub.
- 3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
- 4. External mounting flanges.
- 5. Grounding lug.
- 6. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.

E. NEMA 12 Rated:

- 1. Body and cover:
 - a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. Type 5052 H-32 aluminum, unpainted.
- 2. Seams continuously welded and ground smooth.
- 3. No knockouts.
- 4. External mounting flanges.
- 5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
- 6. Flat door with oil resistant gasket.

F. Miscellaneous Accessories:

- 1. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
- 2. Split covers when heavier than 25 LBS.
- 3. Weldnuts for mounting optional panels and terminal kits.
- 4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

G. Standards: NEMA 250, UL 50.

2.11 SUPPORT SYSTEMS

- A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
 - 1. Material requirements:
 - a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
 - b. Stainless steel: AISI Type 316.
 - c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.
- B. Single Conduit and Outlet Box Support Fasteners:
 - 1. Material requirements:
 - a. Zinc plated steel.
 - b. Stainless steel.
 - c. Malleable iron.
 - d. PVC coat malleable iron or steel: 20 MIL PVC coating.
 - e. Steel protected with zinc phosphate and oil finish.

2.12 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

- A. Sleeves, smoke and fire stop fitting through walls and floors:
 - 1. See Specification Section 01 73 20.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

- A. Shall be in accordance with the requirements of:
 - 1. NFPA 70.
 - 2. Manufacturer instructions.
- B. Size of Raceways:
 - 1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
 - 2. Unless specifically indicated otherwise, the minimum raceway size shall be:
 - a. Conduit: 3/4 IN.
 - b. Wireway: 2-1/2 IN x 2-1/2 IN.
- C. Field Bending and Cutting of Conduits:
 - 1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
 - 2. Do not reduce the internal diameter of the conduit when making conduit bends.
 - 3. Prepare tools and equipment to prevent damage to the PVC coating.
 - 4. Degrease threads after threading and apply a zinc rich paint.
 - 5. Debur interior and exterior after cutting.
- D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.
- E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
 - 1. Repair galvanized components utilizing a zinc rich paint.
 - 2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
 - 3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
 - a. Total nominal thickness: 40 MIL.
 - 4. Repair surfaces which will be inaccessible after installation prior to installation.

- F. Remove moisture and debris from conduit before wire is pulled into place.
 - 1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
 - 2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
 - 3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.
- G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.
- H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.
- I. Fill openings in walls, floors, and ceilings and finish flush with surface.
 - 1. See Specification Section 01 73 20.

3.2 RACEWAY ROUTING

- A. Raceways shall be routed in the field unless otherwise indicated.
 - 1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
 - 2. Run in straight lines parallel to or at right angles to building lines.
 - 3. Do not route conduits:
 - a. Through areas of high ambient temperature or radiant heat.
 - b. In suspended concrete slabs.
 - c. In concrete members including slabs, slabs on grade, beams, walls, and columns unless specifically located and detailed on structural Drawings.
 - 4. Locate sleeves or conduits penetrating floors, walls, and beams so as not to significantly impair the strength of the construction. Do not place conduit penetrations in columns.
 - 5. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
 - 6. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 DEG of bends in the conduit run or in long straight runs to limit pulling tensions.
- B. All conduits within a structure shall be installed exposed except as follows:
 - 1. As indicated on the Drawings.
 - 2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
 - 3. Conduits in architecturally finished areas shall be concealed.
- C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
 - 1. Between instrumentation and telecommunication: 1 IN.
 - 2. Between instrumentation and 125 V, 48 V and 24 VDC, 2 IN.
 - 3. Between instrumentation and 600 V and less AC power or control: 6 IN.
 - 4. Between instrumentation and greater than 600 VAC power: 12 IN.
 - 5. Between telecommunication and 125 V, 48 V and 24 VDC, 2 IN.
 - 6. Between telecommunication and 600 V and less AC power or control: 6 IN.
 - 7. Between telecommunication and greater than 600 VAC power: 12 IN.
 - 8. Between 125 V, 48 V and 24 VDC and 600 V and less AC power or control: 2 IN.
 - 9. Between 125 V, 48 V and 24 VDC and greater than 600 VAC power: 2 IN.
 - 10. Between 600 V and less AC and greater than 600 VAC: 2 IN.
 - 11. Between process, gas, air and water pipes: 6 IN.
- D. Conduits shall be installed to eliminate moisture pockets.
 - 1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.
- E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

- F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.
- G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
 - 1. See Specification Section 01 73 20.

3.3 RACEWAY APPLICATIONS

- A. Permitted Raceway Types Per Wire or Cable Types:
 - 1. Power wire or cables: All raceway types.
 - 2. Control wire or cables: All raceway types.
 - 3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
 - 4. Motor leads from a VFD: RGS.
 - 5. Telecommunication cables: All raceway types.
- B. Permitted Raceway Types Per Area Designations:
 - 1. Dry areas:
 - a. RGS.
 - b. RAC.
 - 2. Wet areas:
 - a. RGS.
 - b. RAC.
 - c. Fiberglass (above grade rated).
 - 3. Corrosive areas:
 - a. PVC-RGS.
 - b. RAC.
 - c. Fiberglass (above grade rated).
 - 4. Highly corrosive areas:
 - a. PVC-RGS.
 - b. PVC-80.
 - c. Fiberglass (above grade rated).
 - 5. NFPA 70 hazardous areas:
 - a. RGS.
- C. Permitted Raceway Types Per Routing Locations:
 - 1. In stud framed walls:
 - a. EMT.
 - 2. In concrete block or brick walls:
 - a. PVC-40.
 - 3. Above acoustical tile ceilings:
 - a. EMT.
 - b. NEMA 1 rated wireway.
 - 4. Embedded in poured concrete walls and floors:
 - a. PVC-40.
 - b. Fiberglass (above or below grade rated).
 - c. Fiberglass (above grade rated) when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
 - d. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
 - 5. Beneath floor slab-on-grade:
 - a. PVC-40.
 - b. Fiberglass (above or below grade rated).
 - 6. Through floor penetrations, see Specification Section 01 73 20:
 - a. Fiberglass (above grade rated) in areas designated as wet, corrosive or highly corrosive.
 - b. PVC-RGS in areas designated as wet, corrosive or highly corrosive.
 - 7. Direct buried conduits and ductbanks:
 - a. PVC-80.
 - b. Fiberglass (above or below grade rated).

- c. 90 DEG elbows for transitions to above grade:
 - 1) PVC-RGS.
 - 2) Fiberglass (above grade rated).
 - d. Long sweeping bends greater than 15 DEG:
 - 1) PVC-RGS.
 - 2) Fiberglass (above or below grade rated).
- 8. Concrete encased ductbanks:
 - a. PVC-40.
 - b. PVC-EB.
 - c. Fiberglass (above or below grade rated).
 - d. 90 degree elbows for transitions to above grade:
 - 1) PVC-RGS.
 - 2) Fiberglass (above grade rated).
 - e. Long sweeping bends greater than 15 DEG:
 - 1) RGS for sizes 2 IN and larger.
 - 2) Fiberglass (above or below grade rated).
- D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
 - 1. The maximum length shall not exceed:
 - a. 6 FT to light fixtures.
 - b. 3 FT to all other equipment.
- E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
 - 1. The maximum length shall not exceed:
 - a. 6 FT to light fixtures.
 - b. 3 FT to motors.
 - c. 2 FT to all other equipment.
- F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
 - 1. The maximum length shall not exceed:
 - a. 3 FT to motors.
 - b. 2 FT to all other equipment.
- G. NEMA 1 Rated Wireway:
 - 1. Surface mounted in electrical rooms.
 - 2. Surface mounted above removable ceilings tiles of an architecturally finished area.
- H. NEMA 4X Rated Wireway:
 - 1. Surface mounted in areas designated as wet and or corrosive.
- I. NEMA 12 Rated Wireway:
 - 1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.
- J. Underground Conduit: See Specification Section 26 05 43.

3.4 CONDUIT FITTINGS AND ACCESSORIES

- A. Conduit Seals:
 - 1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
 - 2. Fill plug and drain shall be accessible.
 - 3. Pour the conduit seals in a two-step process.
 - a. Pour the seal and leave cover off.
 - b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.

- B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
 - 1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.
- C. Install Expansion Fittings:
 - 1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
 - 2. Elsewhere as identified on the Drawings.
- D. Install Expansion/Deflection Fittings:
 - 1. Where conduits enter a structure.
 - a. Except electrical manholes and handholes.
 - b. Except where the ductbank is tied to the structure with rebar.
 - 2. Where conduits span structural expansions joints.
 - 3. Elsewhere as identified on the Drawings.
- E. Threaded connections shall be made wrench-tight.
- F. Conduit joints shall be watertight:
 - 1. Where subjected to possible submersion.
 - 2. In areas classified as wet.
 - 3. Underground.
- G. Terminate Conduits:
 - 1. In metallic outlet boxes:
 - a. RGS:
 - 1) Conduit hub and locknut.
 - 2) Insulated bushing and two locknuts.
 - 3) Use grounding type locknut or bushing when required by NFPA 70.
 - b. EMT: Compression type connector and locknut.
 - 2. In NEMA 1 rated enclosures:
 - a. RGS:
 - 1) Conduit hub and locknut.
 - 2) Insulated bushing and two locknuts.
 - 3) Use grounding type locknut or bushing when required by NFPA 70.
 - b. EMT: Compression type connector and locknut.
 - 3. In NEMA 12 rated enclosures:
 - a. Watertight, insulated and gasketed hub and locknut.
 - b. Use grounding type locknut or bushing when required by NFPA 70.
 - 4. In NEMA 4 and NEMA 4X rated enclosures:
 - a. Watertight, insulated and gasketed hub and locknut.
 - 5. In NEMA 7 and NEMA 9 rated enclosures:
 - a. Into an integral threaded hub.
 - 6. When stubbed up through the floor into floor mount equipment:
 - a. With an insulated grounding bushing on metallic conduits.
 - b. With end bells on nonmetallic conduits.
- H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

- A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
 - 1. Dry or wet and/or hazardous areas:
 - a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
 - b. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.

2. Corrosive areas:
 - a. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.
 - b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
 3. Highly corrosive areas:
 - a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
 - b. Fiberglass system consisting of: Fiberglass channels and fittings, nuts and hardware and conduit clamps.
 4. Conduit type shall be compatible with the support system material.
 - a. Galvanized steel system may be used with RGS.
 - b. Stainless steel system may be used with RGS.
 - c. PVC coated galvanized steel system may be used with PVC-RGS.
 - d. Fiberglass system may be used with PVC-40 and PVC-80.
- B. Permitted single conduit support fasteners per area designations and conduit types:
1. Architecturally finished areas:
 - a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
 - b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
 - c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
 2. Dry or wet and/or hazardous areas:
 - a. Material: Zinc plated steel, stainless steel and malleable iron.
 - b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
 3. Corrosive areas:
 - a. Material: Stainless steel and PVC coat malleable iron or steel.
 - b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
 4. Highly corrosive areas:
 - a. Material: PVC coat malleable iron or steel.
 - b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
 5. Conduit type shall be compatible with the support fastener material.
 - a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS.
 - b. Stainless steel system may be used with RGS.
 - c. PVC coated fasteners may be used with PVC-RGS.
 - d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.
- C. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
 2. Support conduit from the building structure.
 3. Do not support conduit from process, gas, air or water piping; or from other conduits.
 4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
 - a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
 - b. Conduit hangers:
 - 1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
 - c. Do not use suspended ceiling support systems to support raceways.
 - d. Hangers in metal roof decks:
 - 1) Utilize fender washers.

- 2) Not extend above top of ribs.
- 3) Not interfere with vapor barrier, insulation, or roofing.
- 5. Conduit support system fasteners:
 - a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
 - b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:

- 1. Install products in accordance with manufacturer's instructions.
- 2. See Specification Section 26 05 00 and the Drawings for area classifications.
- 3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
- 4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:

- 1. Permitted uses of metallic outlet boxes:
 - a. Housing of wiring devices:
 - 1) Recessed in all stud framed walls and ceilings.
 - 2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
 - b. Pull or junction box:
 - 1) Above gypsum wall board or acoustical tile ceilings.
 - 2) Above 10 FT in an architecturally finished area where there is no ceiling.
- 2. Permitted uses of cast outlet boxes:
 - a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
 - b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
- 3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
- 4. Set device outlet boxes plumb and vertical to the floor.
- 5. Outlet boxes recessed in walls:
 - a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
 - b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
- 6. Place barriers between switches in boxes with 277 V switches on opposite phases.
- 7. Back-to-back are not permitted.
- 8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

C. Pull and Junction Boxes:

- 1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
 - a. Make covers of boxes accessible.
- 2. Permitted uses of NEMA 1 enclosure:
 - a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
- 3. Permitted uses of NEMA 4 enclosure:
 - a. Pull or junction box surface mounted in areas designated as wet.
- 4. Permitted uses of NEMA 4X metallic enclosure:
 - a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
- 5. Permitted uses of NEMA 7 enclosure:
 - a. Pull or junction box surface mounted in areas designated as Class I hazardous.
 - 1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

6. Permitted uses of NEMA 12 enclosure:
 - a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

SECTION 26 05 43
ELECTRICAL - EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Manholes.
 - b. Handhole.
 - c. Underground conduits and ductbanks.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Division 03 - Concrete.
 - 4. Section 10 14 00 - Identification Devices.
 - 5. Section 26 05 26 - Grounding.
 - 6. Section 26 05 33 - Raceways and Boxes.
 - 7. Section 31 23 00 - Earthwork.
 - 8. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. HB-17, Standard Specifications for Highway Bridges.
 - 2. ASTM International (ASTM):
 - a. A536, Standard Specification for Ductile Iron Castings.
 - 3. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 4. Society of Cable Telecommunications Engineers (SCTE):
 - a. 77, Specifications for Underground Enclosure Integrity.

1.3 DEFINITIONS

- A. Direct-Buried Conduit(s):
 - 1. Individual (single) underground conduit.
 - 2. Multiple underground conduits, arranged in one or more planes, in a common trench.
- B. Concrete Encased Ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - 3. Fabrication and/or layout drawings:
 - a. Provide dimensional drawings of each handhole and manhole indicating all specified accessories and conduit entry locations.
 - 1) Provide dimensioned, cross-sectioned sketch of each penetration and each side.
 - b. Provide cross-sectioned sketch of each concrete encased ductbank.
 - 1) Dimension spacing between conduits.

- 2) Dimension concrete envelope and reinforcing, where applicable.
- c. Provide cross-section sketch of each direct-buried ductbank.
 - 1) Dimension from grade to direct buried ductbank.
 - 2) Dimension from direct buried ductbank to other utilities in the route.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Prefabricated composite handholes:
 - a. Armorcast Products Company.
 - b. Quazite by Hubbell.
 - c. Synertech by Oldcastle Enclosure Solutions.
 - 2. Precast manholes and handholes:
 - a. Lister Industries Ltd.
 - b. Oldcastle Enclosure Solutions.
 - c. Jensen Precast and Utility Concrete Products.
 - 3. Manhole and handhole and ductbank accessories:
 - a. Cantex, Inc.
 - b. Condux International, Inc.
 - c. Neenah Enterprises, Inc.
 - d. Prime Conduit.
 - e. Thomas and Betts.
 - f. Underground Devices, Inc.
 - g. Unistrut by Atkore International, Inc.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANHOLES AND HANDHOLES

- A. Prefabricated Composite Material Handholes:
 - 1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
 - 2. Minimum load ratings: SCTE 77 Tier 15.
 - 3. Open bottom.
 - 4. Stackable design as required for specified depth.
 - 5. Cover:
 - a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
 - b. Non-gasketed bolt down with stainless steel penta head bolts.
 - c. Lay-in non-bolt down, when cover is over 100 LBS.
 - d. One or multiple sections so the maximum weight of a section is 125 LBS.
 - 6. Cover lifting hook: 24 IN minimum in length.
- B. Precast Manholes and Handholes:
 - 1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
 - 2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
 - 3. Mating edges: Tongue and groove type.
 - 4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
 - 5. Provide hole or knockout in bottom for ground rod.
 - a. Diameter: as required, 2 IN minimum.
 - 6. Cable pulling eyes opposite all conduit entrances.
 - a. Coordinate exact location with installation contractor.

2.3 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

- A. Cover and Frame:

1. Cast ductile iron: ASTM A536.
 2. AASHTO live load rating: H-20.
 3. Diameter: 30 IN.
 4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.
- B. Cable Racks and Hooks:
1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
 2. Hook loading capacity: 400 LBS minimum.
 3. Rack loading capacity: Four hooks maximum.
 4. Hook deflection: 0.25 IN maximum.
 5. Hooks: Length, as required, with positive locking device to prevent upward movement.
 6. Mounding hardware: Stainless steel.
- C. Cable Pulling Irons:
1. 7/8 IN DIA hot-dipped galvanized steel.
 2. 6000 LB minimum pulling load.
- D. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

- A. Concrete and reinforcing steel: See Division 03 Specifications.
- B. Conduit: See Specification Section 26 05 33.
- C. Duct Terminators:
1. Window type.
 2. ABS plastic.
 3. Provide for conduit entrance.
 4. Designed for installation into manhole or handhole walls for a watertight seal.
 5. Sufficient space between terminator walls to allow for placement of rebar and concrete.
- D. Duct Spacers/Supports:
1. High density polyethylene or high impact polystyrene.
 2. Interlocking web or mesh design.
 3. Provide 3 IN minimum spacing between conduits.
 4. Accessories, as required:
 - a. Hold down bars.
 - b. Ductbank strapping.

PART 3 - EXECUTION

3.1 GENERAL

- A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.
1. Field conditions may affect actual routing.
- B. Manhole and Handhole Locations:
1. Approximately where shown on the Drawings.
 2. As required for pulling distances.
 3. As required to keep pulling tensions under allowable cable tensions.
 4. As required for number of bends in ductbank routing.
 5. Shall not be installed in a swale or ditch.
 6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
 7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.
- C. Install products in accordance with manufacturer's instructions.

- D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.
- E. Comply with Specification Section 31 23 33 for trenching, backfilling and compacting.

3.2 MANHOLES AND HANDHOLES

- A. Prefabricated Composite Material Handholes:
 - 1. For use in areas subjected to occasional non-deliberate vehicular traffic.
 - 2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
 - 3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
 - 4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
 - 5. Size: As indicated on the Drawings or as required for the number and size of conduits.
 - 6. Provide cable rails and pulling eyes as needed.
- B. Precast Manholes and Handholes:
 - 1. For use in vehicular and non-vehicular traffic areas.
 - 2. Construction:
 - a. Grout or seal all joints, per manufacturer's instructions.
 - b. Support cables on walls by cable racks:
 - 1) Provide a minimum of two racks, install symmetrically on each wall of manholes and handholes.
 - a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
 - 2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
 - c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
 - 1) Drill opening in floor for ground rod.
 - 2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
 - 3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three.
 - a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
 - 3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
 - 4. Install so that the top of cover is 1 IN above finished grade.
 - a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
 - 5. After installation is complete, backfill and compact soil around manholes and handholes.
 - 6. Handhole size:
 - a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
 - 7. Manhole size:
 - a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.

3.3 UNDERGROUND CONDUITS

- A. General Installation Requirements:
 - 1. Duct bank Schedule:
 - a. Duct banks are designated by alphanumeric callouts on the Drawings. These callouts correspond to the duct banks listed below in the Duct Bank Schedule.

- b. Provide duct banks as shown in the Duct Bank Schedule; duct/conduit sizes shown in the Duct Bank Schedule are required duct/conduit sizes.
 - 1) Where these circuits continue to the source or load within buildings, conduit sizes can be adjusted to match conduit sizes shown in the Feeder Schedule shown on the Drawings.
 - c. Duct Banks shall be concrete encased or direct buried as indicated in the Duct Bank Schedule.
- 2. Do not place concrete or soil until conduits have been observed by the Engineer.
- 3. Duct Banks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
 - a. Low points shall be at manholes or handholes.
- 4. During construction and after conduit installation is complete, plug the ends of all conduits.
- 5. Provide conduit supports and spacers.
 - a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
 - 1) 1 IN and less: 3 FT.
 - 2) 1-1/4 to 3 IN: 5 FT.
 - 3) 3-1/2 to 6 IN: 7 FT.
 - b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
 - 1) 1 IN and less: 10 FT.
 - 2) 1-1/4 to 2-1/2 IN: 14 FT.
 - 3) 3 IN and larger: 20 FT.
 - c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
- 6. Stagger conduit joints at intervals of 6 IN vertically.
- 7. Make conduit joints watertight and in accordance with manufacturer's recommendations.
- 8. Accomplish underground changes in direction of runs exceeding a total of 15 DEG by long sweep bends having a minimum radius of 10 FT.
 - a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
- 9. Furnish manufactured elbows at end of runs as the conduit transitions to above grade.
 - a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.
- 10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
- 11. After the conduit run has been completed:
 - a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
 - 1) Test mandrel:
 - a) Length: Not less than 12 IN.
 - b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
 - b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
- 12. Pneumatic rodding may be used to draw in lead wire.
 - a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
 - b. Extend cord 3 FT beyond ends of conduit.
- 13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
 - a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
 - b. Terminate rigid PVC conduits with end bells.
 - c. Terminate steel conduits with insulated bushings.
- 14. Place warning tape in trench directly over duct banks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10 14 00.

15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.
- B. Concrete Encased Duct Bank:
1. Duct bank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.
 2. Install so that top of concrete encased duct, at any point:
 - a. Is not less than 24 IN below grade.
 - b. Is below pavement sub-grading.
 3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.
 - a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 03 Specification Sections or as detailed on the Drawings.
 - b. Conduit supports to be staggered to minimize weak vertical shear point.
 4. Conduit supports shall provide a uniform minimum clearance of 3 IN between the bottom of the trench and the bottom row of conduit.
 5. Conduit separators shall provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
- C. Direct-Buried Conduit(s):
1. Install so that the top of the uppermost conduit, at any point:
 - a. Is not less than 30 IN below grade.
 - b. Is below pavement sub-grading.
 2. Provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
 - a. Maintain the separation of multiple planes of conduits by one of the following methods:
 - 1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 PSI) per Specification Section 31 23 33 or concrete per Division 03 specifications.
 - 2) Install the multilevel conduits one level at a time.
 - a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 23 33, to maintain the required separations.

END OF SECTION

SECTION 26 05 48
ELECTRICAL SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The design and installation of seismic bracing and anchorage required for electrical equipment, conduit, and control panels.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Civil Engineers (ASCE):
 - a. 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
 - 2. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A307, Standard Specification Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 PSI Tensile Strength.
 - c. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 KSI (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.
 - e. A992/A992M, Standard Specification for Structural Steel Shapes.
 - f. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 KSI Yield Strength.
 - 3. Building code (current applicable editions, including amendments, for project location):
 - a. International Code Council (ICC):
 - 1) International Building Code and associated standards, referred to herein as Building Code.
 - b. International Building Code (IBC).
 - c. National Fire Protection Association (NFPA) 5000 Building Construction and Safety Code.

1.3 SYSTEM DESCRIPTION

- A. Contractor is responsible for design and installation of seismic bracing and anchorage systems.
- B. Description of Systems:
 - 1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
 - 2. Anchorage of floor and roof mounted electrical equipment.
- C. Seismic Design Requirements:
 - 1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit and control panels, designed, constructed, and installed to resist stresses produced by lateral forces.
- D. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and all suspended or wall mounted equipment weighing 20 LBS or more.
- E. The following components are exempt from the requirements of this Specification Section:
 - 1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor (I_p) is equal to 1.0.

2. Electrical components in Seismic Design Categories D, E, and F where $I_p = 1.0$ and flexible connections between the components and associated conduit are provided and that are mounted at 4 FT (1.22 M) or less above a floor level and weigh 400 LBS (1780 N) or less.
 3. Electrical components in Seismic Design Categories D, E, and F weighing 20 LBS (95 N) or less where $I_p = 1.0$ and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 LBS/FT (7 N/M) or less.
- F. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data:
 - a. Seismic control devices.
 3. Fabrication and/or layout drawings:
 - a. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
 - b. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location.
 - 1) Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
 - c. Structural calculations for required lateral force level for each component.
 - d. All submittals, including pre-approved systems, shall be signed and sealed by a licensed engineer, licensed in the state in which the project is located.

1.5 PROJECT CONDITIONS

- A. Seismic (Earthquake) Loads:
1. Reference the Earthquake Design Data on Sheet 01S101 of the Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pre-engineered suspended bracing systems:
 - a. International Seismic Application Technology (ISAT) "Engineered Seismic Bracing of Suspended Utilities".
 - b. Unistrut by Atkore International, Inc.
 - c. TOLCO by Eaton.
 - d. B-Line by Eaton.
 2. Custom engineered systems designed using specified criteria and common building materials.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 EQUIPMENT ANCHORS AND SUPPORTS

- A. Drilled-in-place concrete anchors shall have an approved ICBO Evaluation Services Report.
- B. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554, 36 ksi.
- C. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.
- D. Structural steel for supports: ASTM A36, A588, A992 or A500.
- E. Cold formed metal and connection material: Unistrut, or equal.

- F. Any details provided are based on assumed equipment and arrangement.
 - 1. The Contractor shall be responsible for design and acquiring approval for support and anchorage of equipment and arrangement which varies from equipment and arrangement assumed in detail provided.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Every run which requires bracing shall have a minimum of two transverse braces and one longitudinal brace.
 - 1. A "run" is defined as suspended pipe, conduit, cable tray, bus duct or trapeze rack having a minimum 10 FT straight run length.
- B. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.
- C. Bracing may be omitted from conduit, cable tray and bus duct runs less than 10 FT in length.
- D. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 IN. (305 MM) in length are required.
 - 1. All unbraced suspended utility systems having 2 IN conduit and larger or systems weighing more than 5 LBS/FT shall be installed with a minimum 6 IN clearance to suspended ceiling vertical hanger wires.
 - 2. The conduit, cable tray, or bus duct shall be installed such that the lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.
- E. A longitudinal brace at a 90 DEG change in direction may act as a transverse brace if it is located within 2 FT of the change in direction.
- F. A transverse brace may act as a longitudinal brace if it is located within 2 FT of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.
- G. When bracing equipment or a utility system that is suspended from an overhead deck, brace back to the overhead deck or to the supporting structure supporting the deck.
 - 1. Do not brace to another element of the structure which may respond differently during a seismic event.
- H. Obtain approval from the Structural Engineer prior to attaching any brace elements to structural steel or wood framing.
- I. When utilizing cable bracing, tension the cable to remove slack without inducing uplift of the suspended element.
 - 1. Tension seismic bracing system prior to system start-up and adjust if necessary after equipment start-up.
- J. As a general rule, do not mix rigid bracing with cable bracing in the same run.
 - 1. However, once bracing has transitioned a 90 DEG change in run direction, the bracing may switch from rigid to cable or vice versa if required due to a significant change in overhead deck elevation or to provide an implementable bracing scheme in a congested area.
- K. Install brace members at an angle of 45 DEG from horizontal within a tolerance of +2-1/2 DEG or -45 DEG provided the brace length is accounted for in design.
 - 1. Brace angle may be increased to 60 DEG provided the brace spacing is reduced to 1/2 that required for a 45 DEG brace.
- L. Seismic bracing may not pass through a building separation joint.
 - 1. Utility systems that pass through a separation joint must be seismically restrained no greater than 5 FT from the point of connection.

2. Any hardware designed to accommodate seismic movement across the span of the separation joint shall be installed per manufacturer's installation and listing instructions.
- M. With approval of the Structural Engineer, utility systems that are suspended from the overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that the walls and the overhead decks will respond similarly during a seismic event.
- N. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.
- O. Conduit, cable tray, or bus duct constructed of non-ductile material (plastic or fiberglass), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials.
- P. Where brace elements are through-bolted, the mounting hole in the element is to be no more than 1/16 IN in diameter larger than the bolt or threaded rod.
- Q. Seismic braces shall directly brace the support and not the hanger.

3.2 SUSPENDED ELECTRICAL SYSTEMS

- A. Install seismic bracing for all conduit 2-1/2 IN trade size or greater.
- B. All trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering the total weight of the elements on the trapeze.
 1. For the purposes of calculating weight, all conduits are to be treated as full.
- C. Brace all trapeze racks which support conduit 2-1/2 IN trade size or larger.
 1. Brace all other conduit rack, cable tray or bus duct trapezes having a minimum weight in excess of 10 LBS/LF.
 2. Include a minimum 10 PCT additional capacity for future additions.
- D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 IN or less in length from the top of the element to the bottom of the structural attachment of the hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.
- E. For steel and aluminum bus ducts, conduit and cable trays:
 1. Provide transverse bracing at 40 FT maximum spacing unless otherwise noted.
 2. Provide longitudinal bracing at 80 FT maximum spacing unless otherwise noted.
- F. All vertical risers involving conduit 2-1/2 IN in diameter or larger shall include lateral restraint at maximum 30 FT intervals and at the top and bottom of the riser.
- G. Make provisions to eliminate seismic impact between components.

3.3 FLOOR OR ROOF MOUNTED EQUIPMENT

- A. Provide one anchor on each leg or corner.
 1. Support with a minimum of three 3/8 IN DIA anchors.
- B. Friction shall be neglected when designing anchors for shear.
- C. Vertical seismic forces, when required, shall be presumed to act concurrently with horizontal seismic forces.
- D. Batteries on racks or for generators shall have wrap around restrains to ensure that the batteries will not slide laterally. Spacers shall be used between the restrains and cases to prevent damage to the cases.
- E. Electrical cabinet design shall comply with the applicable NEMA standards. Cutouts in the lower shear panel that have not been made by the manufacturer and reduce significantly the strength of the cabinet shall be specifically evaluated.

END OF SECTION

SECTION 26 05 74

SHORT CIRCUIT AND COORDINATION STUDY, AND ARC FLASH REPORT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies the short circuit and protective-device coordination study, and arc flash study and report, for the electrical power system for the Kalama Creek Hatchery (Upper Site and Lower Site).
 - 1. The "electrical power system" starts at each utility transformer and includes the service equipment, standby generator, motor control centers, panelboards, and VFDs.
 - 2. Arc flash study shall include the method and recommendation in determining proper Personal Protective Equipment (PPE) and proper labeling of equipment as specified in this Section.
 - 3. Provide equipment labeling.
- B. Reports shall include the utility transformers, service equipment, standby generator, switchboard, motor control centers, VFDs and panelboards.
 - 1. Field data as needed shall be determined and gathered by the Contractor after Notice to Proceed to accomplish the Arc Flash Report and Coordination Study.
 - 2. The report shall include existing electrical equipment and electrical equipment being installed in this Construction Contract.

1.2 RELATED SECTIONS

- A. Related Sections include but are not necessarily limited to:
 - 1. Section 26 05 00 - Electrical: Basic Requirements.

1.3 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. This Section incorporates by reference the latest revision of the following documents.
 - 2. These references are a part of this Section as specified and modified.
 - 3. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

REFERENCE	TITLE
IEEE 1584	IEEE Guide for Performing Arc-Flash Hazard Calculations
NFPA 70	National Electrical Code
NFPA 70E	Standard for Electrical Safety Requirements for Employee Workplaces
OSHA 29-CFR	Occupational Safety and Health Standards: Electrical Part 1910 Subpart S

- B. Qualifications:
 - 1. Prepared by the manufacturer of the electrical equipment or by an electrical testing service or an Engineering Company which is regularly engaged in power system studies.
 - 2. All calculations shall be prepared by or prepared under direct supervision of a Washington State Licensed Professional Electrical Engineer.
- C. Certification:
 - 1. Short circuit and coordination study and arc flash report to be stamped and signed by a Washington State Licensed Professional Electrical Engineer.

1.4 SUBMITTALS

- A. Short circuit and coordination study report.
- B. Arc flash report.

- C. Arc flash warning labels for the electrical equipment being installed in this construction contract.
- D. Provide complete set of model files used to perform study to Owner's Representative as part of O&M documentation.

1.5 SHORT CIRCUIT AND COORDINATION STUDY

- A. Coordinated Power System Protection:
 - 1. A study shall be prepared to demonstrate that the equipment and system constructed within the scope of these Contract Documents meet the specified requirements for equipment ratings, coordination and protection.
 - a. The studies shall be performed in accordance with IEEE 242 and IEEE 399.
 - 2. Computer generated studies shall include the information about the software: name of the developer and software package and version number.
 - 3. System short circuit study report:
 - a. The study shall include the utility transformers and extend down the system through all buses.
 - b. A balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study shall be performed.
 - c. A one-line diagram shall be prepared to show the electrical system buses, generator, transformers and all sources of fault current including generators and motors.
 - d. Manufacturer's data for the actual proposed equipment shall be utilized (e.g., transformer impedance).
 - e. The available utility fault current shall be coordinated with the power utility company.
 - f. Input data shall be shown in tabular form in the report and/or on the one-line diagram.
 - 1) Input data shall include but is not limited to:
 - a) Utility fault current or MVA and X/R ratio.
 - b) Bus voltages.
 - c) Conductor sizes and type of conduit.
 - d) Motor sizes and contributions.
 - e) Generator size and contributions.
 - f) Transformer sizes and impedances.
 - g. Available fault current at each bus shall be shown in tabular form in the report and/or on the one-line diagram.
 - h. Perform studies for both normal power and standby power scenarios.
 - 4. System protective coordination study report:
 - a. The study shall begin at each main service electrical switchgear and extend down the system through all buses as required to ensure a coordinated power system.
 - b. The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions.
 - 1) Where necessary an appropriate compromise shall be made between system protection and service continuity.
 - 2) System protection and service continuity shall be considered to be of equal importance.
 - c. A one-line diagram shall be prepared to show the electrical system buses, generator, transformers and protective devices.
 - d. Manufacturer's data for the actual proposed protective devices shall be utilized.
 - e. Summarize the coordination study, conclusions and recommendations.
 - 1) As a minimum, include the following:
 - a) The manufacturer's information used to prepare the study.
 - b) Assumptions made during the study.
 - c) Recommended taps and settings of all adjustable devices in tabulated form.
 - d) Composite coordination time-current curves on log-log paper showing:
 - (1) That the settings for each protective device will provide protection and selectivity.
 - (2) Identify each curve.

- (3) Cable and equipment damage points.
 - (4) Circuit interrupting device operating and interrupting times.
 - e) One-line sketch of the part of the system being investigated.
 - f) Include as many curves as possible on a graph while maintaining readability.
- f. Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
- g. Advise the Engineer of potential coordination problems discovered during the study and include recommendations to resolve the problem.

1.6 ARC FLASH STUDY

- A. Perform arc flash hazard studies after the short circuit and protective device coordination studies have been completed.
- B. For each major part of the electrical power system, determine the following:
 - 1. Flash hazard protection boundary.
 - 2. Limited approach boundary.
 - 3. Restricted approach boundary.
 - 4. Prohibited approach boundary.
 - 5. Incident energy level.
 - 6. PPE hazard/risk category.
 - 7. Type of PPE required.
- C. Produce arc flash warning labels listing items B 1-7 from above.
 - 1. Also include the bus name and voltage.
- D. Produce bus detail sheets that list the items B 1-7 from above and the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, and type.
 - 3. Bus line to line voltage.
- E. Produce an arc flash evaluation summary sheet listing the following additional items:
 - 1. Bus name matching existing and contract document identification numbers.
 - 2. Upstream protective device name, and type.
 - a. Numbering shall match existing and contract document identification numbers.
 - 3. Bus line to line voltage.
 - 4. Bus bolted fault.
 - 5. Protective device bolted fault current.
 - 6. Arcing fault current.
 - 7. Protective device trip/delay time.
 - 8. Breaker opening time.
 - 9. Solidly grounded column.
 - 10. Equipment type.
 - 11. Gap.
 - 12. Arc flash boundary.
 - 13. Working distance.
 - 14. Incident energy.
 - 15. Required protective fire rated clothing type and class.
- F. Analyze the short circuit, protective device coordination and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation.
 - 1. Propose approaches to reduce the energy levels. Where possible the hazard/risk category shall be reduced to Category 2 and still maintain proper coordination through the means of resetting of breakers and relays.

1.7 ARC FLASH REPORT

- A. Prepare a report summarizing the arc flash study and conclusions or recommendations which may affect the integrity of the electric power distribution system.
- B. A qualified engineer must perform arc flash calculations to determine the incident energy, arc flash boundary, and minimum PPE requirements for locations throughout the power system.
 - 1. Arc flash warning labels shall be produced and attached to the electrical equipment by the Contractor.
 - 2. These labels must indicate approach boundaries, incident energy level, and the minimum PPE that is required when servicing the equipment within the arc flash boundary.
- C. As a minimum, include the following in the report:
 - 1. Equipment manufacturer's information for the equipment installed.
 - 2. Assumptions made during the study.
 - 3. Reduced copy of the one line drawing.
 - 4. Arc flash evaluations summary spreadsheet.
 - 5. Bus detail sheets.
 - 6. Arc flash warning labels printed in color on adhesive backed labels.
- D. Submit report 60 days before energizing electrical equipment.
 - 1. Labels shall be affixed on all new equipment prior to the new equipment being energized.

PART 2 - PRODUCTS

2.1 LABELS

- A. Provide weatherproof labels for equipment mounted outdoors.

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform each arc flash study in accordance with NFPA 70E, OSHA 29-CFR, Part 1910 Subpart S, and IEEE 1584 Standards.
- B. Perform the studies using actual equipment data for the equipment provided.
 - 1. Provide data from the manufacturer of the protective relays, circuit breakers, fuses, devices, etc. provided by the contractor's subcontractors and vendors.
- C. Provide arc flash warning labels on equipment as specified in this Section.
 - 1. Labels shall be printed in color on adhesive backed labels.
- D. Set all low voltage circuit breakers settings/ratings as determined by the coordination study. Fuse ratings on equipment shall be based on the coordination study.

END OF SECTION

SECTION 26 08 13

ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for acceptance testing.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 01 61 03 - Equipment - Basic Requirements.
 - 4. Section 26 32 14 - Engine Generator - Diesel.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. InterNational Electrical Testing Association (NETA):
 - a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
 - 2. Nationally Recognized Testing Laboratory (NRTL).
 - 3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
 - a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.
- B. Qualifications:
 - 1. Testing firm qualifications: See Specification Section 01 61 03.
 - 2. Field personnel:
 - a. See Specification Section 01 61 03.
 - b. As an alternative, supervising technician may be certified by the equipment manufacturer.
 - 3. Analysis personnel:
 - a. See Specification Section 01 61 03
As an alternative, supervising technician may be certified by the equipment manufacturer.
- C. Phasing Diagram:
 - 1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
 - a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 01 61 03 for electrical equipment and connection testing plan submittal requirements.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Prior to energizing equipment:
 - a. Coordinated phasing diagram.

- b. Photocopies of continuity tests for all circuits connected to transfer switch and motor control center.
- 3. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
 - a. Single report containing information including:
 - 1) Summary of Project.
 - 2) Information from pre-energization testing.
 - 3) See testing and monitoring reporting requirements in Specification Section 01 61 03.
 - 4) Forms documenting each inspection and test performed.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

- A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.
- B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 01 61 03.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. General:
 - 1. See Specification Section 01 61 03.
 - 2. Complete electrical testing in three phases:
 - a. Pre-energization testing phase.
 - b. Equipment energized with no load.
 - c. Equipment energized under load.
 - 3. Perform testing in accordance with this Specification Section and NETA ATS.
 - 4. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.
- B. Equipment Monitoring and Testing Plan: See Specification Section 01 61 03.
- C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 01 61 03.
- D. Testing and Monitoring Program Documentation: See Specification Section 01 61 03.
- E. Electrical Equipment and Connections Testing Program:
 - 1. See Specification Section 01 61 03.
 - 2. See individual Division 26 Specification Sections for equipment specific testing requirements.
 - 3. Test all electrical equipment.
 - a. Perform all required NETA testing.
 - b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

- A. Switchgear and Switchboards:
 - 1. Perform inspections and tests per NETA ATS 7.1.
 - 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
- B. Transformers - Small Dry Type:
 - 1. Perform inspections and tests per NETA ATS 7.2.1.1.
 - 2. Perform the following additional tests:

- a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2 PCT of nominal under normal load after approval of Engineer.
4. Record as-left tap connections.
- C. Cable - Low Voltage:
 1. Perform inspections and tests per NETA ATS 7.3.2.
- D. Low Voltage Molded Case Circuit Breakers:
 1. Perform inspections and tests per NETA ATS 7.6.1.1.
 2. Components:
 - a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
 - b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
 - c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
 3. Record as-left settings.
- E. Grounding:
 1. Perform inspections and tests per NETA ATS 7.13.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
- F. Motors:
 1. Perform inspections and tests per NETA ATS 7.15.
 2. See Specification Section 01 61 03.
- G. Motor Controllers:
 1. Perform inspections and tests per NETA ATS 7.16.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
- H. Generators:
 1. Perform inspections and tests per NETA ATS 7.15.2.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
 3. Perform the following additional tests:
 - a. Load and cycle crank test per Specification Section 26 32 14.
 - b. Perform additional tests per Specification Section 26 32 14.
- I. Variable Frequency Drives:
 1. Perform inspections and tests per NETA ATS 7.17.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
- J. Control System Functional Test:
 1. Perform test upon completion of equipment acceptance tests.
 2. The test is to prove the correct interaction of all sensing, processing and action devices.
 3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
 4. Perform the following tests:
 - a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 - b. Verify the correct operation of all sensing devices, alarms and indicating devices.

END OF SECTION

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SECTION 26 09 16
CONTROL EQUIPMENT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
 - 2. Control devices (timers, relays, contactors, etc.).
 - 3. Industrial Control Panels.
 - 4. Operator Control Stations.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
 - c. ICS 5, Control Circuit and Pilot Devices.
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 508, Standard for Safety Industrial Control Equipment.
 - b. 508A, Standard for Industrial Control Panels.
 - c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

1.3 SYSTEM DESCRIPTION

- A. This Specification specifies components used within other equipment as referenced in other technical specifications.
- B. This Specification is used to specify the components and construction of Operator Local Control Stations:
- C. This Specification is used to specify the components and construction of following Industrial Control Panels.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification:
 - 1) When components are used within equipment specified in another Section, submittal data for components specified herein shall be included with the submittal for the equipment the components are used in.
 - b. Industrial Control Panel bill of material.
 - c. Control Station bill of material.
 - d. See Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings.
 - a. Industrial Control Panel:
 - 1) Interior and exterior layout.

- 2) Wiring/connection diagrams.
 - 3) Copy of the UL 508A label.
 - 4) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.
 - b. Operator Control Station:
 - 1) Interior (if applicable) and exterior layout.
 - 2) Wiring/connection diagrams.
 - c. Provide a table that associated Industrial Control Panel and Operator Control Stations with associated equipment name and tagging.
- B. Informational Submittals:
- 1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Functional Test Plan.
- C. Contract Closeout Information:
- 1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - b. Content of Operation and Maintenance Manual:
 - 1) Product technical data of components used within Industrial Control Panels and Operator Control Stations.
 - 2) As-constructed wiring/connection diagrams for Industrial Control Panels and Operator Control Stations.
 - 3) Operating instructions for time clocks.
 - 4) Functional Test Report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
- 1. Pilot devices, relays, contactors, and termination equipment:
 - a. Allen-Bradley by Rockwell Automation, Inc.
 - b. ATC Diversified Electronics by Bellofram Group of Companies.
 - c. ASCO by Emerson Electric Co.
 - d. c3controls.
 - e. Eaton.
 - f. General Electric.
 - g. IDEC Corporation.
 - h. Phoenix Contact.
 - i. Potter and Brumsfield (P&B) by TE Connectivity.
 - j. Schneider Electric.
 - k. Siemens Corporation.
 - l. Time Mark Corporation.
 - 2. Photocells and time clocks:
 - a. Grasslin by Intermatic.
 - b. Tork by NSi Industries.
 - c. Intermatic.
 - d. Paragon Auto Control.
 - 3. Alarm devices:
 - a. Edwards Signaling by United Technologies Corp.
 - b. Federal Signal Corporation.
 - 4. Enclosures:
 - a. Hoffman Engineering.
 - b. Wiegmann by Hubbell.

- c. B-Line by Eaton.
- d. Adalet.
- e. Stahlin by Robroy Enclosures.

2.2 PILOT DEVICES

- A. General Requirements:
 - 1. Standards: NEMA ICS 5, UL 508.
 - 2. Heavy-duty NEMA 4/13 watertight/oiltight.
 - 3. Heavy-duty NEMA 4/4X corrosion resistant.
 - 4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
 - 5. Mounting hole: 30.5 MM.
 - 6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
 - 7. Legend plate marked as indicated on Drawings or specified.
- B. Selector Switches:
 - 1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
 - 2. Maintained contact type.
 - 3. Knob or lever type operators.
- C. Pushbuttons:
 - 1. Non-illuminated type:
 - a. Protective boot.
 - b. Momentary contact.
 - c. Standard flush and mushroom operators.
 - d. Black colored buttons for START or ON and red color for STOP or OFF.
 - e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.
- D. Indicating Lights:
 - 1. Allowing replacement of bulb without removal from control panel.
 - 2. Lamp: LED, 120 V or 24 V as required.
 - 3. Full voltage type.
 - 4. Push-to-test indicating lights.
 - 5. Plastic lens.
 - 6. Color code lights as follows:
 - a. Green: ON or running; valve open.
 - b. Amber: FAULT; WARNING; ALERT.
 - c. Red: OFF or stopped; valve closed.
 - d. White: control power on, remote, or general status condition.

2.3 RELAYS

- A. General Requirements:
 - 1. Standards: NEMA ICS 5, UL 508.
- B. Control Relays:
 - 1. General purpose (ice cube) type:
 - a. Plug-in housing.
 - b. Clear polycarbonate dust cover with clip fastener.
 - c. Coil voltage: 120 VAC or as required.
 - d. Contacts:
 - 1) 10 amp continuous.
 - 2) Silver cadmium oxide.
 - 3) Minimum of 3 SPDT contacts.
 - e. Sockets: DIN rail mounted.
 - f. Internal neon or LED indicator is lit when coil is energized.
 - g. Manual operator switch.

2. Industrial type:
 - a. Coil voltage: 120 VAC or as required.
 - b. Contacts:
 - 1) 10 amp, NEMA A600 rated.
 - 2) Double break, silver alloy.
 - 3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
 - 4) Expandable from 2 poles to 12 poles.
 - c. Provide contacts for all required control plus two spares.
- C. Time Delay Relays:
 1. General purpose type:
 - a. Timing modes: On and Off delay, interval, one shot and repeat cycle.
 - b. Plug-in housing.
 - c. Polycarbonate dust cover with clip fastener.
 - d. Coil voltage: 120 VAC or as required.
 - e. Contacts:
 - 1) 10 amp continuous.
 - 2) Silver cadmium oxide.
 - 3) Two normally open and two normally closed DPDT contacts.
 - f. Sockets: DIN rail mounted.
 - g. External timing adjustment knob.
 - h. Timing ranges: 0.05 seconds to 16.65 HRS.
 - i. Repeat accuracy: +1 PCT.
 2. Solid State industrial type:
 - a. Timing modes: On and Off delay and repeat cycle.
 - b. Industrial housing.
 - c. Coil voltage: 120 VAC or as required.
 - d. Contacts:
 - 1) 5 amp, NEMA B150 rated.
 - 2) Silver alloy.
 - 3) Convertible On Delay and Off Delay contacts.
 - 4) One normally open and one normally closed timed contacts.
 - 5) One normally open and one normally closed instantaneous contacts.
 - e. Furnish with "on" and "timing out" indicators.
 - f. External timing adjustment knob.
 - g. Timing ranges: 0.05 seconds to 10 HRS.
 - h. Repeat accuracy: +1 PCT.
 3. Mechanical industrial type:
 - a. Timing modes: On and Off delay.
 - b. Coil voltage: 120 VAC or as required.
 - c. Contacts:
 - 1) 10 amp, NEMA A600 rated.
 - 2) Double break, silver alloy.
 - 3) Convertible On Delay and Off Delay contacts.
 - 4) Convertible normally open and normally closed timed contacts.
 - 5) Convertible normally open instantaneous contacts.
 - d. External timing adjustment knob.
 - e. Timing ranges: 0.2 - 60 seconds or 5 - 180 seconds.
 - f. Repeat accuracy: Greater than +10 PCT.

2.4 CONTACTORS

- A. General Requirements:
 1. Standards: NEMA ICS 2, UL 508.

- B. Lighting and Remote Control Switches:
 - 1. Electrically operated, electrically held.
 - 2. Coil voltage: 120 VAC or as required.
 - 3. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
 - 4. Rated for ballasted lighting, tungsten and general use loads.
 - 5. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
 - 6. Auxiliary control relays, as indicated on Drawings or as specified.
 - 7. Auxiliary contacts, as indicated on Drawings or as specified.
- C. Definite Purpose:
 - 1. Coil voltage: 120 VAC or as required.
 - 2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
 - 3. Resistive load and horsepower rated.
 - 4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
 - 5. Auxiliary contacts, as indicated on Drawings or as specified.

2.5 PHOTOCELLS AND TIME CLOCKS

- A. Photocells:
 - 1. Weatherproof enclosure.
 - 2. Adjustable turn-on range, initially set at 1.0 foot-candles.
 - a. Turn-off level approximately three times turn-on.
 - 3. Provide time delay device to eliminate nuisance switching.
 - 4. Voltage, amperage and/or wattage ratings as required for the application.
- B. General Requirements for Time Clocks:
 - 1. Separate manual on-off operation without disturbing automatic settings.
 - 2. Enclosure:
 - a. NEMA 1 for indoor locations.
 - b. Stand alone or DIN rail for mounting in control panel.
 - c. NEMA 4 for exterior locations.
 - 3. Voltage, amperage and/or wattage ratings as required for the application.
- C. Electronic:
 - 1. 24 HR and seven day programmable using solid state technology.
 - 2. Minimum of 72 HR carryover power utilizing rechargeable battery or capacitor.
 - 3. Minimum of seven on and seven off set points.
- D. Electronic:
 - 1. 365 day programmable using solid state technology with block programming.
 - 2. Minimum of 72 HR carryover power utilizing rechargeable battery or capacitor.
 - 3. Minimum of 48 events per week, 16 individual holiday overrides, daylight savings or standard time selectable, automatic leap year correction.
- E. Astronomical Clocks:
 - 1. Adjustable for the installed latitude.
 - a. Settings for astro on/astro off, astro on/time off or time on/astro off.
 - 2. 365 day programmable using solid state technology with block programming.
 - 3. Minimum of 72 HR carryover power utilizing rechargeable battery or capacitor.
 - 4. Minimum of 48 events per week, 16 individual holiday overrides daylight savings or standard time selectable, automatic leap year correction.

2.6 ALARM DEVICES

- A. Alarm Horns:
 - 1. Vibrating horn type.
 - 2. PLC compatible as required.
 - 3. Heavy-duty die cast housing with corrosion resistant finish.

4. Adjustable volume: 78 to 103 dB at 10 FT.
 5. Voltage: 120 VAC or as required.
 6. Enclosures/mountings:
 - a. Flush wall or panel mounting in dry areas.
 - b. NEMA 4X panel mounting in wet areas.
 - c. Surface mounting in dry areas.
 - d. NEMA 4X surface mounting in wet areas.
 - e. NEMA 4X, hazardous location surface mounting in wet and hazardous areas.
 - 1) Fixed volume: 97 dB at 10 FT.
- B. Alarm Lights:
1. Panel mounted:
 - a. Strobe type.
 - b. Shatter resistant polycarbonate lens and base.
 - c. Lens color as indicated on Drawings.
 - d. NEMA 4X enclosure.
 - e. PLC compatible.
 - f. Voltage: 120 VAC.
 2. Wall mounted:
 - a. Heavy-duty strobe type.
 - b. Weatherproof shatter resistant polycarbonate lens and cast base.
 - c. Optically designed fresnel lens with color as indicated on Drawings.
 - d. Immune to shock and vibration, no moving parts.
 - e. Xenon flash tube providing a minimum of 65 single flashes per minute.
 - f. Mounting: Wall or corner wall brackets.

2.7 MISCELLANEOUS DEVICES

- A. Run Time Meters:
1. Six-digit wheels including a 1/10 digit.
 2. Non-reset type.
 3. Time range in hours.
 4. Automatic recycle at zero.
 5. Accuracy: 1 PCT.
 6. Sealed against dirt and moisture.
 7. Tamperproof.
- B. Control Power Transformer:
1. Primary voltage: 480 V.
 2. Secondary voltage: 120 V.
 3. Sized for 125 PCT of required load.
 4. Fused on primary and secondary.
 5. Standard: NEMA ST 1.

2.8 TERMINATION EQUIPMENT

- A. General Requirements:
1. Modular type with screw compression clamp.
 2. Screws: Stainless steel.
 3. Current bar: Nickel-plated copper alloy.
 4. Thermoplastic insulation rated for -40 to +90 DEGC.
 5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
 6. End sections and end stops at each end of terminal strip.
 7. Machine-printed terminal markers on both sides of block.
 8. Spacing: 6 MM.
 9. Wire size: 22-12 AWG.
 10. Rated voltage: 600 V.
 11. DIN rail mounting.

- B. Standard-Type Block:
 - 1. Rated current: 30 A.
 - 2. Color: Gray body.
- C. Bladed-Type Disconnect Block:
 - 1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
 - 2. Rated current: 10 A.
 - 3. Color:
 - a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
 - b. Foreign voltage entering enclosure: Orange body, orange switch.
- D. Grounded-Type Block:
 - 1. Electrically grounded to mounting rail.
 - 2. Terminal ground wires and analog cable shields.
 - 3. Color: Green and yellow body.
- E. Fuse Holders:
 - 1. Blocks can be ganged for multi-pole operation.
 - 2. Spacing: 9.1 MM.
 - 3. Wire size: 30-12 AWG.
 - 4. Rated voltage: 300 V.
 - 5. Rated current: 12 A.
 - 6. Fuse size: 1/4 x 1-1/4.
 - 7. Blown fuse indication.
 - 8. DIN rail mounting.

2.9 ENCLOSURES

- A. Industrial Control Panels:
 - 1. NEMA 4 rated:
 - a. Seams continuously welded and ground smooth.
 - b. No knockouts.
 - c. External mounting flanges.
 - d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
 - e. Cover with oil resistant gasket.
 - 2. NEMA 4X rated:
 - a. Body and cover: 14 GA Type 304 or 316 stainless steel.
 - b. Seams continuously welded and ground smooth.
 - c. No knockouts.
 - d. External mounting flanges.
 - e. Hinged door and stainless steel screws and clamps.
 - f. Door with oil-resistant gasket.
 - 3. NEMA 12 enclosure:
 - a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. No knockouts.
 - c. External mounting flanges.
 - d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
 - e. Flat door with oil resistant gasket.
 - 4. Control panel miscellaneous accessories:
 - a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
 - b. Interiors shall be white or light gray in color.
 - c. Wire management duct:
 - 1) Bodies: PVC with side holes.
 - 2) Cover: PVC snap-on.

- 3) Size as required.
 - d. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
 - e. Split covers when heavier than 25 LBS.
 - f. Floor stand kits made of same material as the enclosure.
 - g. Weldnuts for mounting optional panels and terminal kits.
 - h. Ground bonding jumper from door, across hinge, to enclosure body.
- 5. Standards: NEMA 250, UL 508.
- B. Operator Local Control Stations:
 - 1. NEMA 4/13 rated:
 - a. Die cast aluminum body with manufacturer's standard finish.
 - b. Gasketed die cast aluminum cover with manufacturer's standard finish.
 - c. Number of device mounting holes as required.
 - 2. NEMA 4X rated:
 - a. Type 304 or 316 stainless steel body.
 - b. Gasketed Type 304 or 316 stainless steel cover.
 - c. Number of device mounting holes as required.

2.10 FABRICATION

- A. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A or UL 698A.
 - 1. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
 - 2. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - a. Determine the SCCR rating by one of the following methods:
 - 1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - 2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - 3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
 - 3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Control Panels:
 - 1. Size as required to mount the equipment.
 - 2. Permitted uses of enclosure types:
 - a. See Material Application Schedule in Specification Section 26 05 00 and area environmental designation on the Drawings.
- C. Operator Control Stations:
 - 1. Permitted uses of enclosure types:
 - a. See Material Application Schedule in Specification Section 26 05 00 and area environmental designation on the Drawings.

3.2 FIELD QUALITY CONTROL

- A. See Section 26 05 00.
- B. Industrial Control Panel(s) and Operator Control Station Functional Test:
 - 1. The test is to prove the correct interaction of all sensing, processing and action devices.
 - 2. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
 - a. Plan shall have witness signature lines for the contractor and engineer or owner's representative and submitted when system pass the test.
 - 3. Perform the following tests:
 - a. Verify functionality of all control states.
 - b. Verify the correct operation of all interlock safety devices for fail-safe functions
 - c. Verify the correct operation of all sensing devices, alarms and indicating devices.

3.3 TRAINING

- A. A qualified supplier representative shall provide the Owner with on-site training in the operation and maintenance of the Industrial Control Panel(s) and its components.

END OF SECTION

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SECTION 26 22 13
DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dry-type transformers, 1000 kVA and less.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 26 - Grounding.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Department of Energy (DOE):
 - a. 10 CFR 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ST 20, Dry Type Transformers for General Applications.
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. 506, Standard for Specialty Transformers.
 - b. 1561, Standard for Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings.
 - a. Nameplate drawing.
 - 4. Certifications:
 - a. Sound level certifications.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Eaton.

2. General Electric.
3. Square D by Schneider Electric.
4. Siemens.
5. SolaHD by Emerson Electric Co.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

- A. Ventilated or non-ventilated, air cooled, two winding type.
- B. Cores:
 1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
 2. Magnetic flux densities are to be kept well below the saturation point.
- C. Coils: Continuous wound with electrical grade aluminum.
- D. Ventilated Units:
 1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
 2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.
- E. Furnish Taps for Transformers as follows:
 1. 1 PH, 2 kVA and below: None.
 2. 1 PH, 3 to 25 kVA: Two, 5 PCT FCBN.
 3. 1 PH, 25 kVA and above: Two, 2.5 PCT FCAN and four, 2.5 PCT FCBN.
 4. 3 PH, 3 to 15 kVA: Two, 5 PCT FCBN.
 5. 3 PH, 15 kVA and above: Two, 2.5 PCT FCAN and four, 2.5 PCT FCBN.
- F. Sound Levels:
 1. Manufacturer shall guarantee not to exceed the following:
 - a. Up to 9 kVA: 40 dB.
 - b. 10 to 50 kVA: 45 dB.
 - c. 51 to 150 kVA: 50 dB.
 - d. 151 to 300 kVA: 55 dB.
- G. Efficiency (minimum):
 1. Ventilated:
 - a. 1 PH, 15 - 333 kVA: DOE 2016 Efficiency.
 - b. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.
- H. Insulating Material (600 V and below):
 1. 3 to 15 kVA units: 185 DEGC insulation system with a 115 DEGC rise.
 2. 15 kVA and above units: 220 DEGC insulation system with a 150 DEGC rise.
- I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.
- J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.
- K. Standards: IEEE C57.96, NEMA ST 20, UL 506, UL 1561.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Indoor Locations:
 1. Provide ventilated type for 15 kVA units and above.
 2. Provide non-ventilated type for 9 kVA units and below and were indicated on the Drawings.

3. Mount 9 kVA units and below on wall.
 4. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 26 05 00.
 5. Provide rubber vibrations isolation pads.
- C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.
- D. Ground in accordance with Section 26 05 26.

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Branch circuit panelboards.
 - 2. Distribution panelboards.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 – Identification Devices.
 - 4. Section 26 05 00 - Electrical - Basic Requirements.
 - 5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
 - 6. Section 26 43 13 – Low Voltage Surge Protection Devices (SPD).

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. PB 1, Panelboards.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - b. 67, Standard for Panelboards.

1.3 DEFINITIONS

- A. Branch Circuit Panelboard: Bus rating of 400A and less or where labeled as Branch Circuit Panelboard on the Drawings.
- B. Distribution Panelboard: Bus rating of 600A and greater or where labeled as Distribution Panelboard on the Drawings.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Panelboard schedules with as-built conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Eaton.
 - 2. ABB/GE.
 - 3. Square D by Schneider Electric.
 - 4. Siemens Corporation.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

- A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.
- B. Ratings:
 - 1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
 - 2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
 - a. Series rating is not acceptable.
 - b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
 - c. Minimum SCCR ratings:
 - 1) Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating.
 - d. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating.
 - 3. Service Entrance Equipment rated when indicated on the Drawings or when shown to be fed from a utility source.
- C. Construction:
 - 1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
 - 2. Multi-section panelboards: Feed-through or sub-feed lugs.
 - 3. Main lugs: Solderless type approved for copper and aluminum wire.
- D. Bus Bars:
 - 1. Main bus bars:
 - a. Tin plated aluminum or tin plated copper sized to limit temperature rise to a maximum of 65 DEGC above an ambient of 40 DEGC.
 - b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
 - 2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
 - 3. Neutral bus bars: Insulated 100 PCT rated or 200 PCT rated, when indicated on the Drawings and with solderless mechanical type connectors.
- E. Overcurrent and Short Circuit Protective Devices:
 - 1. Main overcurrent protective device:
 - a. Molded case circuit breaker.
 - 2. Branch overcurrent protective devices:
 - a. Molded case circuit breaker.
 - 3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
 - 4. Factory installed.
- F. Integral surge protective device:
 - 1. Provide for each panelboard.
 - 2. Provide Type 3 SPD.
 - 3. See Specification Section 26 43 13.
- G. Enclosure:

1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Branch circuit panelboard:
 - a. Trims supplied with hinged door-in-door construction.
 - 1) Outer door:
 - a) Allows access to the interior of the enclosure.
 - b) Hinged to the enclosure.
 - c) Opened by removal of screws or by operating a mechanical latch located behind the inner door.
 - 2) Inner door:
 - a) Allows access to breakers (non-live parts).
 - b) Hinged to outer door.
 - c) Opened by operation of a keyed corrosion resistant chrome-plated combination lock and catch. Locks for all branch circuit panelboards keyed alike.
 - b. Trims for surface mounted panelboards, same size as box.
 - c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
 - d. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
 - e. Clear plastic cover for directory card mounted on the inside of each door.
 - f. Where NEMA 3R or NEMA 12 rating is indicated: Door gasketed.
 - g. Where NEMA 4X is indicated: Stainless Steel.
4. Distribution panelboard:
 - a. Trims cover all live parts with switching device handles accessible.
 - b. Minimum 8 IN deep and less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
 - c. Clear plastic cover for directory card mounted front of enclosure.
 - d. Where NEMA 3R or NEMA 12 rating is indicated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike, or provisions for padlocks.
 - e. Where NEMA 4X is indicated: Stainless Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.
- B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.
- C. Provide NEMA rated enclosure as indicated on the Drawings. Where enclosure type is not indicated, provide enclosure rating suitable for the atmosphere where equipment is installed.
- D. Field identification:
 1. Provide all required tagging and markings per the NFPA 70 and Specification Section 10 14 00.
- E. Provide each panelboard with a typed directory:
 1. Identify all circuit locations in each panelboard with the load type and location served.
 2. Use Owner-furnished mechanical equipment designation if different than designation indicated on the Drawings.
 3. Use final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.
 4. Identify spare overcurrent devices.
- F. Equipment Marking and Documentation:

1. Provide labeling per NFPA 70 and other applicable codes.
2. Service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
 - b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
3. Other than service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
 - b. Available fault current label. (Ref. NFPA 70 Article 408.6)
4. Identify (tag) all equipment and equipment components.
5. Provide labels and tags in accordance with Section 10 14 00.
6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Separately mounted motor starters (including those supplied with equipment).
 - 2. Manual motor starters.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
 - 5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
 - 6. Section 26 09 16 - Control Equipment Accessories.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. International Electrotechnical Commission (IEC).
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
 - b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
 - c. ICS 18, Motor Control Centers.
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 508, Standard for Industrial Control Equipment.
- B. Miscellaneous:
 - 1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
 - 2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Separately mounted combination starters:
 - 1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated including industry standard symbology of the field devices as indicated on the Drawings, specification and/or loop descriptions. Drawings indicate basic control functionality, provide diagrams for the manufacturer's product(s) meeting the required functionality.
 - 2) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.

- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - b. Fabrication and/or layout drawings updated with as-built conditions.
- C. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Service equipment marking and documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Allen-Bradley by Rockwell Automation, Inc.
 - 2. Eaton.
 - 3. ABB/General Electric.
 - 4. Square D by Schneider Electric.
 - 5. Siemens Corporation.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 SEPARATELY MOUNTED COMBINATION STARTERS

- A. Standards:
 - 1. NEMA 250, NEMA ICS 2.
 - 2. UL 508.
- B. Enclosure:
 - 1. NEMA 4 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
 - b. No knockouts, external mounting flanges, hinged and gasketed door.
 - 2. NEMA 4X rated:
 - a. Body and cover: Type 304 or 316 stainless steel.
 - b. No knockouts, external mounting flanges, hinged and gasketed door.
 - 3. NEMA 12 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
 - b. No knockouts, external mounting flanges, hinged and gasketed door.
- C. Operating Handle:
 - 1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
 - 2. Circuit breaker and MCP operators includes a separate TRIPPED position.
 - 3. Mechanical interlock to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
 - 4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
 - 5. Padlockable in the OFF position.
- D. External mounted overload relay pushbutton.
- E. Control Devices:
 - 1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
 - 2. Devices will be accessible with the door closed.

- F. Control Power Transformer:
 - 1. 120V secondary.
 - 2. Fused on primary and secondary side.
 - 3. Sized for 140 PCT of required load.
- G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.
- H. Motor Starters: See requirements within this Specification Section.
- I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
 - 1. Motor circuit protector.
 - 2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
 - 3. Factory installed.

2.3 MOTOR STARTERS

- A. Standards:
 - 1. NEMA ICS 2.
 - 2. UL 508.
- B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
 - 1. NEMA full size rated contactor.
 - a. NEMA half sizes and IEC contactors are not permitted.
 - 2. Double-break silver alloy contacts.
 - 3. Overload relays:
 - a. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.
 - 4. Interlock and auxiliary contacts, wired to terminal blocks:
 - a. Holding circuit contact, normally open.
 - b. Overload alarm contact, normally open.
 - c. Normally open auxiliary contact, for remote run status.
 - d. Additional field replaceable auxiliary contacts as required per the and Control (Elementary) Diagram.
 - e. Two additional normally open spare field replaceable auxiliary contacts.
- C. Variable Frequency Drives: See Specification Section 26 29 23.

2.4 MANUAL MOTOR STARTERS

- A. Standards:
 - 1. NEMA 250, NEMA ICS 2.
 - 2. UL 508.
- B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.
- C. Types:
 - 1. Horsepower rated, for ON/OFF control.
 - 2. Horsepower rated, for ON/OFF control and thermal overload protection.
 - a. Switch to clearly indicate ON, OFF, and TRIPPED position.
- D. Voltage and current ratings and number of poles as required for the connected motor.
- E. Enclosures:
 - 1. NEMA 4 rated:
 - a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
 - b. No knockouts, external mounting flanges.
 - 2. NEMA 4X rated:
 - a. Type 304 or 316 stainless steel.
 - b. No knockouts, external mounting flanges.

3. NEMA 12 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
 - b. No knockouts, external mounting flanges.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.
- B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.
- C. Service Equipment Marking and Documentation:
 1. Provide service rated equipment with available fault current and arc-flash hazard warning labels as required by NFPA 70 and other applicable codes.
 2. Provide documentation of the calculations made for compliance with the marking requirements.
 3. Provide labels in accordance with Section 10 14 00.
- D. Provide separately mounted combination starters with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 1. Determine the SCCR rating by one of the following methods:
 - a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
 3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.
- E. Overload Heaters:
 1. Size for actual motor full load current of the connected motor.
 2. For motors with power factor correction capacitors, size to compensate for the capacitors effect on load current.
- F. Combination and Manual Starter Enclosures:
 1. Permitted uses of enclosure types:
 - a. See Material Application Schedule in Specification Section 26 05 00 and area environmental designation and classifications on Drawings.

3.2 FIELD QUALITY CONTROL

- A. Acceptance Testing: See Specification Section 26 08 13.

END OF SECTION

SECTION 26 26 13
PACKAGE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Package power supply consisting of a transformer and panelboard.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 26 - Grounding.
 - 5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. PB 1, Panelboards.
 - c. ST 20, Dry Type Transformers for General Applications.
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 67, Standard for Panelboards.
 - b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Nameplate drawing.
 - b. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. GE by ABB.
 - 2. Hammond Power Solutions.

3. Square D by Schneider Electric.
4. Eaton.
5. Siemens Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 PACKAGED POWER SUPPLY

A. General:

1. Standards: IEEE C57.96, NEMA PB 1, NEMA ST 20, UL 67 and UL 1561.
2. Package power supply includes a main primary circuit breaker, an encapsulated dry-type transformer and a secondary panelboard with main circuit breaker.

B. Ratings:

1. Single or three-phase as indicated on the Drawings.
2. KVA and voltage ratings as indicated on the Drawings.
3. Suitable for use as service entrance equipment.

C. Transformer:

1. Non-ventilated, air cooled, two winding type.
2. Core and coil assembly encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock resistant seal.
3. Cores:
 - a. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
 - b. Magnetic flux densities are to be kept well below the saturation point.
4. Coils: Continuous wound with electrical grade aluminum and grounded to the enclosure.
5. Insulation system: 185 DEGC with a 115 DEGC rise.
6. Taps: Two, 5 PCT FCBN.
7. Sound levels:
 - a. Manufacturer shall guarantee not to exceed the following:
 - 1) 9 kVA and less: 40 dB.
 - 2) 10 to 30 kVA: 45 dB.

D. Panelboard and Protective Devices:

1. Bus: Aluminum.
2. Factory installed wiring between primary breaker and transformer, secondary breaker and transformer and distribution section.
3. 480 VAC primary circuit breaker: 14,000 AMP minimum interrupting rating.
4. 240 VAC or less secondary circuit breaker: 10,000 AMP minimum interrupting rating.
5. Feeder breakers:
 - a. Plug-in type with 10,000 AMP minimum interrupting rating.
 - b. See Section 26 28 00 for additional requirements.

E. Enclosure:

1. Main, secondary and feeder circuit breakers enclosed with a padlockable hinged door.
2. Wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
3. Totally enclosed, non-ventilated, NEMA 3R, steel finished with a rust inhibitor primer and manufacturer's standard paint.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Ground in accordance with Section 26 05 26 or as indicated on the Drawings.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Wall switches.
 - b. Receptacles.
 - c. Device wallplates and coverplates.
 - d. Plug-in strips.
 - e. Occupancy sensors.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 33 - Raceways and Boxes.
 - 5. Section 26 24 19 - Motor Control Equipment.
 - 6. Section 26 50 00 - Interior and Exterior Lighting.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. WD 1, General Color Requirements for Wiring Devices.
 - c. WD 6, Wiring Devices - Dimensional Requirements.
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 20, General-Use Snap Switches.
 - b. 498, Standard for Attachment Plugs and Receptacles.
 - c. 514A, Metallic Outlet Boxes.
 - d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
 - e. 943, Ground-Fault Circuit-Interrupters.
 - f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
 - g. 1310, Standard for Class 2 Power Units.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Wall switches and receptacles:
 - a. Bryant Electric.
 - b. Cooper Wiring Devices by Eaton.
 - c. Hubbell Incorporated Wiring Device-Kellems.
 - d. Leviton Manufacturing Company.
 - e. Legrand/Pass & Seymour.
 - f. Eaton Crouse-Hinds.
 - g. Appleton Electric Co.
 - h. Hubbell Killark.
 2. Plug-in strip:
 - a. Wiremold/Legrand.
 - b. Walker.
 3. Occupancy sensors:
 - a. Cooper Controls.
 - b. Lighting Design and Control (LD&C).
 - c. Watt Stopper.

2.2 WALL SWITCHES

- A. Basic requirements unless modified in specific requirements paragraph of switches per designated areas or types:
1. Industrial Specification Grade.
 2. Quiet action, snap switch.
 3. Self-grounding with grounding terminal.
 4. Back and side wired.
 5. Solid silver cadmium oxide contacts.
 6. Rugged thermoplastic and/or nylon housing and one-piece switch arm.
 7. Ratings: 20 A, 120/277 VAC.
 8. Switch handle type: Toggle.
 9. Switch handle color: Ivory.
 10. Types as indicated on the Drawings:
 - a. Single-pole.
 - b. Double-pole.
 - c. 3-way.
 - d. Momentary contact.
 11. Standards: UL 20, UL 514A, NEMA WD 1, NEMA WD 6.
- B. Architecturally Finished Area Specific Requirements:
1. Commercial Specification Grade.
 2. Quiet action, snap switch.
 3. Ratings: 15A, 120/277V.
 4. Switch handle type: Decorator rocker or paddle.
 5. Switch handle color: Ivory.
 6. Wallplate:
 - a. 302 or 304 brushed finish stainless steel.
 - b. Single or multiple gang as required.
- C. Dry Non-architecturally Finished Area Specific Requirements:
1. Coverplate for use on surface mounted outlet boxes:
 - a. Cast iron alloy, galvanized and factory painted finish.
 - b. Cast aluminum, natural, lacquer, or factory painted finish.
 - c. Sheet steel, galvanized.

- d. Sheet aluminum.
 - e. 302 or 304 brushed finish stainless steel.
 - f. Single or multiple gang as required.
- 2. Wallplate for use on recessed outlet boxes:
 - a.
 - b. 302 or 304 brushed finish stainless steel.
 - c. Single or multiple gang as required.
- D. Wet or Damp Non-Architecturally Finished or Exterior Area Specific Requirements:
 - 1. Coverplate:
 - a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
 - b. Operator type:
 - 1) Side mounted rocker type handle to operate snap switch.
 - 2) Front mounted lever type handle to operate snap switch.
 - 3) Push/pull operator to operate snap switch.
 - 4) Spring type door to cover snap switch.
 - c. Wet location rated.
 - d. Single or multiple gang as required.
- E. Corrosive and Wet or Damp Area Specific Requirements:
 - 1. Corrosion resistant nickel plated metal parts.
 - 2. Coverplate for use on metallic outlet boxes:
 - a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
 - b. Operator type:
 - 1) Front mounted lever to operate snap switch.
 - 2) Push/pull operator to operate snap switch.
 - 3) Spring type door to cover snap switch.
 - c. Wet location rated.
 - d. Single or multiple gang as required.
 - 3. Coverplate for use on non-metallic outlet boxes:
 - a. High impact thermoplastic, gasketed, stainless steel screws.
 - 1) Front mounted lever to operate snap switch.
 - 2) Spring type door to cover snap switch.
 - b. Wet location rated.
 - c. Single or multiple gang as required.
- F. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
 - 1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
 - 2. Assembly consists of outlet box, snap switch and coverplate.
 - a. NEMA 3, 7 and 9 rated.
 - 3. Outlet box:
 - a. PVC coated galvanized cast iron alloy.
 - b. PVC coated cast aluminum.
 - c. Cast iron alloy, galvanized and factory painted finish.
 - d. Cast aluminum, natural, lacquer, or factory painted finish.
 - 4. Snap switch (EDS Type):
 - a. Enclosed in separate sealing chamber and approved for installation without additional external sealing fittings.
 - b. Sealing chamber has prewired factory sealed pigtail leads.
 - 5. Snap switch (EFS Type):
 - a. Not enclosed in separate sealing chamber requiring external sealing fittings.
 - 6. Coverplate:
 - a. PVC coated galvanized cast iron alloy, gasketed, stainless steel hardware.

- b. PVC coated cast aluminum, gasketed, stainless steel hardware.
- c. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
- d. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
- e. Operator type:
 - 1) Front mounted lever to operate snap switch.
 - 2) Side rocker arm operator to operate snap switch.
- 7. Standards: UL 894.

2.3 RECEPTACLES

- A. Basic requirements unless modified in specific requirements paragraph of receptacles and per designated areas:
 - 1. Industrial Specification Grade.
 - 2. Straight blade.
 - 3. Brass triple wipe line contacts.
 - 4. One-piece grounding system with double wipe brass grounding contacts and self-grounding strap with grounding terminal.
 - 5. Back and side wired.
 - 6. Rating: 20 A, 125 VAC.
 - 7. High impact nylon body.
 - 8. Receptacle body color: Ivory.
 - 9. Duplex or simplex as indicated on the Drawings.
 - 10. Configuration: NEMA 5-20R.
 - 11. Standards: UL 498, UL 514A, NEMA WD 1, NEMA WD 6.
- B. Receptacle Type Specific Requirements:
 - 1. Basic receptacles:
 - a. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
 - 1) Identification: Letters “WR” on face of receptacle.
 - 2. Ground Fault Circuit Interrupter (GFCI):
 - a. Specification Grade.
 - b. Class A protection.
 - c. Feed through type.
 - d. Test and reset buttons.
 - e. Self-testing.
 - f. Visual indicator light.
 - g. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
 - 1) Identification: Letters “WR” on face of receptacle.
 - h. Tamper resistant (TR) when indicated on the Drawings.
 - i. Additional standards: UL 943.
 - 3. Plug load (PL) control receptacle.
 - a. Commercial Specification Grade.
 - b. Dual controlled (PLD) or half controlled (PLH) as indicated on the Drawings.
 - c. Identification: NEMA approved controlled receptacle marking on face of receptacle.
 - 4. Combination receptacle and USB charging station:
 - a. Commercial Specification Grade.
 - b. Compatible with USB 2.0 and 3.0 devices.
 - c. USB ports ratings: 5 VDC, 2.1A minimum total charging capacity.
 - d. Configurations as indicated on the drawings:
 - 1) Simplex receptacle with two (2) USB ports.
 - 2) Duplex receptacle with two (2) USB ports.
 - e. Additional standards: UL 1310.
- C. Architecturally Finished Areas Specific Requirements:
 - 1. Wallplate:

- a. 302 or 304 brushed finish stainless steel.
 - b. Single or multiple gang as required.
- D. Dry Non-Architecturally Finished Areas Specific Requirements:
 - 1. Coverplate for use on surface mounted outlet boxes:
 - a. Cast iron alloy, galvanized and factory painted finish.
 - b. Cast aluminum, natural, lacquer or factory painted finish.
 - c. Sheet steel, galvanized.
 - d. Sheet aluminum.
 - e. 302 or 304 brushed finish stainless steel.
 - f. Single or multiple gang as required.
 - 2. Wallplate for use on recessed outlet boxes:
 - a. 302 or 304 brushed finish stainless steel.
 - b. Single or multiple gang as required.
- E. Wet Non-architecturally Finished Areas Specific Requirements:
 - 1. Coverplate:
 - a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cords.
- F. Exterior Locations Specific Requirements:
 - 1. Coverplate:
 - a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.
- G. Corrosive and Wet or Damp Area Specific Requirements:
 - 1. Corrosion resistant nickel plated metal parts.
 - 2. Receptacle body color: Gray.
 - 3. Weather-resistant.
 - a. Identification: Letters "WR" on face of receptacle.
 - 4. Coverplate for use on metallic outlet boxes:
 - a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.
 - 5. Coverplate for use on non-metallic outlet boxes:
 - a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 IN minimum cover depth for #12 AWG cords.
- H. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
 - 1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
 - 2. Assembly consists of outlet box and a combination receptacle/switch and housing.
 - a. NEMA 3, 7 and 9 rated.
 - 3. Outlet box (EDS Type):
 - a. PVC coated galvanized cast iron alloy.
 - b. PVC coated cast aluminum.
 - c. Cast iron alloy, galvanized and factory painted finish.
 - d. Cast aluminum, natural, lacquer, or factory painted finish.
 - 4. Receptacle/switch and housing:
 - a. Receptacle and switch enclosed in a factory sealed chamber and approved for installation without additional external sealing fittings.
 - b. Insertion of "interchanger" plug and plug rotation will close the switch to energize receptacle and lock plug into the receptacle.
 - c. "Interchanger" plug to be compatible with other manufacturers hazardous receptacle and work in ordinary convenience receptacles.
 - d. Ordinary equipment plugs will not active the hazardous receptacle.
 - e. Housing:

- 1) Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
- 2) Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
- 3) Spring-loaded door seats against neoprene gasket. Stainless steel spring.
5. Ground Fault Circuit Interrupter (GFCI):
 - a. Mount in same type of outlet box as receptacle.
 - b. Enclosed in factory sealed chamber.
 - c. Cover cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
 - d. Buttons stainless steel and gasketed.
 - e. Standards: UL 943.
6. "Interchanger" plug:
 - a. Aluminum housing.
 - b. 30 PCT Glass-reinforced thermoplastic polyester housing.
 - c. Provide five plugs for Owners use.
7. Standards: UL 894 and 1010.
- I. Welding Receptacles:
 1. Combination receptacle and disconnect:
 - a. 100A, 3-pole, NEMA 4X disconnect.
 - b. Zinc plated malleable iron or copper free aluminum, 60 A, 480 V, 3-pole, 3-wire pin and sleeve receptacle.
 2. Zinc plated malleable iron or copper free aluminum, 60 A, 480 V, 3-pole, 3-wire pin and sleeve.
- J. Pin and Sleeve Receptacles:
 1. Zinc plated malleable iron or copper free aluminum, configuration as indicated on the Drawings.
 2. Zinc plated malleable iron or copper free aluminum.
 3. Ratings: As shown in the Drawings.
- K. Special Purpose Receptacles:
 1. NEMA configuration as indicated on the Drawings.
 2. Coverplate: See requirements per area designations herein.

2.4 MISCELLANEOUS WIRING DEVICES

- A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 26 24 19.
- B. Plug-In Strip:
 1. Surface steel raceway plug-in strip with single 15 A, 125 V, 3-wire grounding-type receptacles spaced 18 IN OC.
 2. Prewired with two #12 TW and one #12 TW green insulated ground.
 3. Minimum 1-1/4 IN wide x 3/4 IN deep.
 4. Suitable fittings and snap-in cover.
 5. Finish: Stainless steel.

2.5 OCCUPANCY SENSORS

- A. Low Voltage Passive Infrared Ceiling Sensor (Type per the Drawings):
 1. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
 2. Analog and digital processing to provide immunity to RFI and EMI.
 3. Temperature compensated, dual element sensor and a multi-element lens with a minimum field of view of 110 DEG.
 4. Daylight filter or compensation for short wavelength infrared wave from the sun.
 5. Cover up to 300 SQFT at normal mounting heights.
 6. System voltage: 24 VDC through power pack.
 7. Load ON-OFF control through power pack.

8. Adjustable time delay set at 30 minutes.
 9. Adjustable sensitivity set at maximum.
 10. Adjustments and mounting hardware under a removable cover.
 11. Parallel wiring of multiple sensors to allow coverage of large areas.
- B. Passive Infrared Wall Switch:
1. Self-contained control system that replaces a standard toggle switch.
 - a. Latching air gap relay switching mechanism, compatible with electronic ballasts, compact fluorescent and inductive loads.
 2. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
 3. Analog and digital processing to provide immunity to RFI and EMI.
 4. Temperature compensated, dual element sensor and a multi-element Fresnel lens.
 5. Cover up to 300 SQ FT for walking motion, with a field of view of 180 DEG.
 6. System voltage: 120 VAC or 277 VAC.
 7. No minimum load.
 - a. 0 to 500 watts incandescent, 0 to 800 watts fluorescent or 1/6 HP at 120 VAC, 60 Hz.
 - b. 0 to 1200 watts fluorescent or 1/3 HP at 277 VAC, 60 Hz.
 8. DIP switch to control the following functions:
 - a. Built-in light level feature adjustable from 8 to 180 FT candles.
 - b. AUTOMATIC-ON or MANUAL-ON operation.
 - c. Time delay adjustable from 30 seconds to 30 minutes.
 - d. High/low sensitivity adjustments.
 9. Adjustments and mounting hardware under a removable, tamper resistant cover.
 10. Normal operation: OFF and AUTO.
- C. Ultrasonic Ceiling Sensor:
1. Detection of Doppler shifts in transmitted ultrasound.
 2. Ultrasonic sensing is volumetric in coverage with a frequency of 32 kHz and automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled areas.
 3. Temperature and humidity resistant, 32 kHz tuned ultrasonic receivers.
 - a. Receivers have less than a 6 dB shift in the humidity range of 10 PCT to 90 PCT and less than a 10 dB shift in the temperature range of -20 to 60 DEGC.
 4. DIP switch to control the following functions:
 - a. Override-ON function for use in the event of failure.
 - b. Time delay adjustable from 15 seconds to 30 minutes.
 - c. High/low sensitivity adjustments.
 5. Cover 360 DEG and hallway and corridor sensors shall cover up to 90 linear feet.
 6. Additional single-pole, double-throw isolated relay with normally open, normally closed, and common outputs rated at 1 amp for 24 VDC.
 - a. The isolated relay is for use with HVAC control, data logging and other control options.
- D. Power Pack:
1. Self-contained transformer and relay module.
 2. Dry contacts capable of switching:
 - a. 20 amp ballast load, 13 amp incandescent, 1 HP at 120 VAC, 60 Hz.
 - b. 20 amp ballast at 277 VAC, 60 Hz.
 3. 24 VDC, 100 mA output.
 4. Capable of parallel wiring without regard to AC phases on primary.
 5. Used as a standalone, low voltage switch or wired to sensor for auto control.
 6. Low voltage Teflon coated leads, rated for 300 V, suitable for use in plenum applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.
- C. See Specification Section 26 05 33 for device outlet box requirements.
- D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
- E. Provide blank plates for empty outlets.
- F. Occupancy Sensors:
 - 1. Locations and quantity of sensors shown on the Drawings are diagrammatic and indicate only the rooms and spaces to be provided with sensors.
 - 2. Verify sensor type, quantity, location, aiming and sensitivity with manufacturer's recommendations.
 - 3. All controlled spaces shall be tested to insure 90 to 100 PCT coverage of the controlled space.
 - a. If test fails, adjust sensitivity, re-aim, relocate, and/or add sensor(s) as required at no cost to Owner.
 - 4. Power supplies and slave units if required shall be located above accessible ceilings.

END OF SECTION

SECTION 26 28 00
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low voltage circuit breakers.
 - 2. Low voltage fuses.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
 - c. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 248-12, Low-Voltage Fuses - Part 12: Class R Fuses.
 - b. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - c. 943, Standard for Safety for Ground-Fault Circuit-Interruption.
 - d. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Reports:
 - a. As-left condition of all circuit breakers that have adjustable settings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Circuit breakers:
 - a. Eaton.
 - b. ABB/General Electric Company.
 - c. Square D Company.
 - d. Siemens.
 - 2. Fuses:
 - a. Eaton Bussmann, Inc.
 - b. Littelfuse, Inc.
 - c. Mersen
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 CIRCUIT BREAKERS

- A. Molded Case Type:
 - 1. General:
 - a. Standards: UL 489.
 - b. Unit construction.
 - c. Over-center, toggle handle operated.
 - d. Quick-make, quick-break, independent of toggle handle operation.
 - e. Manual and automatic operation.
 - f. All poles open and close simultaneously.
 - g. Three position handle: On, off and tripped.
 - h. Molded-in ON and OFF markings on breaker cover.
 - i. One-, two- or three-pole as indicated on the Drawings.
 - j. Current and interrupting ratings as indicated on the Drawings.
 - 2. Thermal magnetic type:
 - a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
 - b. Frame size 150 amp and below:
 - 1) Non-interchangeable, non-adjustable thermal magnetic trip units.
 - 3. Solid state trip type:
 - a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
 - b. Removable and sealable covers over adjusting means.
 - c. Frame size 225amp to 600 amp:
 - 1) Standard rating.
 - 2) Interchangeable current sensor or rating plug.
 - 3) Adjustable long time pick-up setting.
 - a) Adjustable from 50 to 100 PCT of the current sensor or rating plug.
 - 4) Adjustable short time pick-up setting.
 - 5) Adjustable instantaneous pick-up.
 - 6) Fixed ground fault pick-up, when indicated on the Drawings.
 - 4. Motor circuit protector:
 - a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
 - b. Sized for the connected motor.

2.3 FUSES

- A. UL Class RK-5 fuses:
 - 1. Standard: UL 248-1 and UL 248-12.
 - 2. Dual-element time-delay and current limiting rejection type.

3. Ratings: 250 and 600 V, 1/10-600 amps and 200,000 RMS AIC symmetrical.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Current and interrupting ratings as indicated on the Drawings.
- B. Series rated systems not acceptable.
- C. Devices shall be ambient temperature compensated.
- D. Circuit Breakers:
 1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
 - a. Frame sizes 150 amp and less shall be thermal magnetic type.
 - b. Frame sizes 225 amp and larger shall be solid state trip type.
 - c. Motor circuit protectors sized for the connected motor.

3.2 FIELD QUALITY CONTROL

- A. Adjustable Circuit Breakers:
 1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.
- B. Ground Fault Protection System:
 1. Single source system:
 - a. Main breaker using the residual sensing method system coordinated with individual feeder breakers using the residual sensing method.
- C. Testing:
 1. Acceptance testing: See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 28 16

SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Safety switches.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
 - c. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
 - 1. Eaton.
 - 2. ABB/General Electric.
 - 3. Square D by Schneider Electric.
 - 4. Siemens Corporation.
 - 5. Appleton by Emerson Electric Co.
 - 6. Crouse-Hinds by Eaton.
 - 7. Killark by Hubbell.

2.2 SAFETY SWITCHES

- A. General:
 - 1. Non-fusible or fusible as indicated on the Drawings.
 - 2. Suitable for service entrance when required.
 - 3. NEMA Type HD heavy-duty construction.
 - 4. Switch blades will be fully visible in the OFF position with the enclosure door open.

5. Quick-make/quick-break operating mechanism.
 6. Deionizing arc chutes.
 7. Manufacture double-break rotary action shaft and switchblade as one common component.
 8. Clear line shields to prevent accidental contact with line terminals.
 9. Operating handle:
 - a. Red and easily recognizable.
 - b. Padlockable in the OFF position.
 - c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.
- B. Ratings:
1. Horsepower rated of connected motor.
 2. Voltage and amperage: As indicated on the Drawings.
 3. Short circuit withstand:
 - a. Non-fused: 10,000A.
 - b. Fused: 200,000A.
- C. Provide the following accessories for each safety switch:
1. Ground lug kits.
 2. Auxiliary contact kits:
 - a. Opens before main switch.
 - b. Rated 10A at 125/250 VAC.
 - c. One N.O. and one N.C. contact.
- D. Enclosures:
1. NEMA 1 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. With or without knockouts, hinged and lockable door.
 2. NEMA 3R rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. With or without knockouts, hinged and lockable door.
 3. NEMA 4 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
 4. NEMA 4X rated (metallic):
 - a. Body and cover: Type 304 or 316 stainless steel.
 - b. No knockouts, external mounting flanges, hinged and gasketed door.
 5. NEMA 12 rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. No knockouts, external mounting flanges, hinged and gasketed door.
- E. Overcurrent and short circuit protective devices:
1. Fuses.
 2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
- F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's instructions and recommendations.
- B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.
- C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
 - 1. The VFD is to be disabled when the switch is in the open position.
- D. Permitted uses of enclosure types:
 - 1. See Material Application Schedule in Specification Section 26 05 00 and area environmental designation and classifications on Drawings.
- E. Permitted uses of NEMA 12 enclosure:
 - 1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

EXHIBIT A

[illegible]

SECTION 26 28 17
SEPARATELY MOUNTED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Separately mounted circuit breakers.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 489, Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. Provide a table that associates equipment model number with equipment tag number.
 - c. See Specification Section 26 05 00 for additional requirements.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Eaton.
 - 2. GE by ABB.
 - 3. Square D by Schneider Electric.
 - 4. Siemens Corporation.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 COMPONENTS

- A. Ratings:
 - 1. Voltage, number of phases, number of wires, and current rating as indicated on the Drawings.
 - 2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
 - 3. Service Entrance Equipment rated when indicated on the Drawings.
 - 4. 100 PCT rated when 100 PCT rated breakers are installed.
- B. Standards: UL 489.
- C. Overcurrent and short circuit protective devices:
 - 1. Molded case circuit breaker.
 - 2. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
 - 3. Factory installed.
- D. NEMA 4 rated:
 - 1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - 2. No knockouts, external mounting flanges, hinged and gasketed door.
 - 3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
 - 4. Suitable for service entrance.
- E. NEMA 4X rated:
 - 1. Body and cover: Type 304 or 316 stainless steel.
 - 2. No knockouts, external mounting flanges, hinged and gasketed door.
 - 3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
 - 4. Suitable for service entrance.
- F. NEMA 12 rated:
 - 1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - 2. No knockouts, external mounting flanges, hinged and gasketed door.
 - 3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
 - 4. Suitable for service entrance.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Permitted uses of enclosure types:
 - 1. See Material Application Schedule in Specification Section 26 05 00 and area environmental designation and classifications on Drawings.
- C. Equipment Marking and Documentation:
 - 1. Provide labeling per NFPA 70 and other applicable codes.
 - 2. Service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
 - b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
 - 3. Other than service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
 - b. Available fault current label. (Ref. NFPA 70 Article 408.6)
 - 4. Identify (tag) all equipment and equipment components.
 - 5. Provide labels and tags in accordance with Section 10 14 00.

6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

END OF SECTION

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SECTION 26 29 23
VARIABLE FREQUENCY DRIVES - LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable frequency drives (VFDs) for operation of inverter duty motors.
 - 2. Variable frequency drives (VFDs) for operation of special purpose submersible induction motors.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.
 - 4. Section 26 05 00 - Electrical - Basic Requirements.
 - 5. Section 01 61 03 - Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American National Standards Institute (ANSI).
 - 2. ETL Testing Laboratories (ETL).
 - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
 - b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
 - c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - 4. National Electrical Manufacturer's Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. MG 1, Motors and Generators.
 - 5. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC):
 - 1) Article 430, Motors Motor Circuits, and Controllers.
 - 6. Occupational Safety and Health Administration (OSHA).
 - 7. Underwriters Laboratory, Inc. (UL):
 - a. 508, Standard for Industrial Control Equipment.
 - b. 508A, Standard for Industrial Control Panels.
- B. Qualifications:
 - 1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
 - 2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
 - a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
 - 3. VFD Supplier shall maintain an authorized service organization within 200 miles of the Project Site.

C. Coordination:

1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
 - a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
2. Motor and VFD coordination: See Specification Section 01 61 03.
3. VFD shall be supplied complete with all required control components.
 - a. Provide control as indicated:
 - 1) On the electrical drawings.
 - 2) As specified in this Specification Section.
 - b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
 - 1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
 - c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.
4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
 - a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
 - b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

1.3 DEFINITIONS

- A. Variable Torque (VT):
1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
 2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.
- B. Constant Torque (CT):
1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
 2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.
- C. Constant Horsepower:
1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
 2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.
- D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.
- E. Standard Motor: An AC induction motor that fails to comply with one or more requirements of NEMA MG 1 Part 31.
- F. Low Voltage: 600 VAC or less.

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Provide a schedule for each VFD including the following information:
 - a. Equipment Tag Number.
 - b. VFD Complete Catalog Number.
 - c. VFD Amp Frame Size.
 - d. Variable or Constant Torque Rating Basis.

- e. Rated Input Current.
- f. Rated Continuous Output Current.
- g. Rated Short Circuit Current.
- h. VFD cable type specified (shielded or non-shielded).
- i. VFD Maximum Motor Lead Length for the type of cable used.
- j. Motor Manufacturer.
- k. Motor Frame Size.
- l. Motor Full Load Amps.
- m. Motor Service Factor.
- n. As installed motor Lead Length.
- o. VFD options provided to meet harmonic or motor protection specifications.
- 3. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
- 4. Product technical data:
 - a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
 - b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
 - c. Manufacturer's installation instructions.
 - d. Manufacturer's programming and operating instructions.
 - e. See Specification Section 26 05 00 for additional requirements.
- 5. Fabrication and/or layout drawings:
 - a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
 - b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
 - c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
 - d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
 - e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
 - f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
- 6. Certifications:
 - a. Submit with Shop Drawings:
 - 1) Identification and location of closest authorized service organization.
 - 2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
 - b. Submit prior to shipment:
 - 1) Certified factory test reports confirming compliance with specified requirements.
 - c. Submit after installation:
 - 1) Certified field service reports showing:
 - a) Each VFD is operational.
 - b) Each VFD and its driven equipment motor are compatible.
 - c) Each VFD responds correctly to the input control signals.
 - d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
 - e) Measured harmonic levels per Harmonic Protection Requirements Article.
 - f) Measured motor terminal peak voltages per Motor Protection Requirements Article.

- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Approved copy of VFD schedule per Submittals Article.
 - 3. Manufacturer's instruction manuals.
 - 4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
 - 5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
 - 6. Recommended spare parts list.
 - 7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Allen Bradley.
 - 2. ASEA Brown Bovari (ABB).
 - 3. Eaton.
 - 4. Danfoss.
 - 5. General Electric Company.
 - 6. Siemens/Robicon.
 - 7. Siemens.
 - 8. Square D Company.
 - 9. Toshiba.
 - 10. Yaskawa.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GENERAL

- A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.
- B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
 - 1. Motor control.
 - 2. Motor overload protection.
 - 3. Motor and motor branch circuit short circuit and ground fault protection.
 - 4. Motor and controller disconnecting means.
- C. It is the intent of this Specification that VFDs shall be an "engineered" or "configured" drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Application:
 - 1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 PCT of base speed of the driven equipment.

2. VFDs shall be compatible with:
 - a. Inverter duty induction motors.
 3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
 - a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
 4. VFDs shall be designed to operate successfully under the following site conditions:
 - a. Ambient:
 - 1) Temperature: 0-40 DEGC.
 - 2) 95 PCT non-condensing relative humidity.
 - b. Elevation: Less than 3,300 FT above MSL.
 - c. Power supply characteristics:
 - 1) 480Vac, 3 PH, 60 Hz, 3 wire, (± 10 PCT).
 - 2) Effectively grounded.
- B. Ratings and Performance Specifications:
1. Voltage rating:
 - a. Nominal: 460 or 480 VAC, 3 PH, 60 Hz.
 - b. Range for continuous full load operation: ± 10 PCT of nominal.
 - c. Voltage imbalance tolerance for full load operation: 3 PCT minimum.
 2. Current ratings:
 - a. Continuous:
 - 1) Equal to or greater than the motor nameplate full load current multiplied by the motor service factor.
 - b. Short-term overload:
 - 1) VT: 110 PCT for 1 minute.
 - 2) CT: 150 PCT for 1 minute.
 - 3) Permissible for 1 minute every 10 minutes continuously.
 - c. Short circuit:
 - 1) As indicated on the Drawings.
 - 2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
 - 3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.
 3. Efficiency:
 - a. 97 PCT, minimum, at full speed and full load.
 - b. 93 PCT, minimum at 1/2 speed and full load.
 4. Displacement power factor:
 - a. 95 PCT, minimum from 50 PCT to 100 PCT speed and load.
 5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
 6. Frequency drift:
 - a. $+0.5$ PCT of set frequency.
 7. Speed regulation (motor dependent): 3 PCT.
 8. Speed range: 10:1.
 9. Control type:
 - a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
 - 1) When operating under voltage boost.
 - 2) At frequencies over 60 Hz.
- C. Operational Features:
1. Insensitive to input phase sequence.
 2. Continued operation with momentary voltage dips of 25 PCT of rated voltage, or single phase condition: 4 SEC, minimum.
 3. Controls power loss ride-through: 500 MSEC, minimum.

4. Electronic reversing.
 5. DC injection braking.
 6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
 7. Critical frequency band lockout:
 - a. Minimum of three settings.
 - b. Adjustable bandwidth, 1 - 5 Hz.
 8. Capable of operating without the motor connected for start-up and troubleshooting.
- D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
 2. Independent maximum and minimum speeds for forward and reverse operation.
 3. Start frequency and hold time.
 4. Independent linear acceleration and deceleration time.
 5. Preset "jog" speed.
 6. Three critical frequency bands.
 7. One preset speed selectable by logic input.
 8. Volts/Hertz ratio.
 9. Voltage boost, magnitude and frequency range.
 10. Process controller gain, offset and bias.
 11. Current limit.
 12. Overcurrent pickup.
 13. Overcurrent delay.
 14. Ground fault pickup.
 15. DC injection level and time.
- E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
1. General:
 - a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
 - 1) Input under voltage.
 - 2) Input over voltage.
 - 3) Input under frequency.
 - 4) Input over frequency.
 - 5) Input Phase loss.
 - 6) DC Bus under voltage.
 - b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
 - 1) Over temperature.
 - 2) Blown fuse.
 - 3) Component failure.
 - 4) Overload.
 - 5) Short circuit.
 - 6) Ground fault.
 - 7) DC Bus over voltage.
 - 8) External safety input (e.g., motor thermal protection).
 - 9) Logic fault.
 - c. When automatic shutdown occurs, VFD shall restart immediately upon reset, whether automatic or manual.
 - d. VFD shall hold cause of trip data for a minimum of four shutdowns in memory.
 - 1) Data to be accessible through the keypad, local communication link and remotely.
 2. Input protection:
 - a. Input circuit breaker or current-limiting fuses with externally operable disconnect.

- 1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
 - 2) Handle padlockable in the OFF position.
 - b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
 - c. Incoming line transient suppression.
 - 1) 6000V peak per IEEE C62.41.
 - 2) Phase-to-phase and phase-to-ground protection.
 - d. Sustained over voltage trip.
- 3. Internal protection:
 - a. Surge suppression and power device snubbers.
 - b. Power devices rated at 2.5 times line voltage.
 - c. Instantaneous over current trip.
 - d. DC bus over voltage trip.
 - e. Power device over temperature trip.
 - f. Control logic circuit malfunction trip.
- 4. Output protection:
 - a. Inverse-time overload trip:
 - 1) UL Class 10 characteristic.
 - b. Over voltage trip.
 - c. Over frequency trip.
 - d. Short circuit trip.
 - 1) Line to line and line to ground.
 - e. Ground fault trip.

2.4 OPERATOR AND REMOTE CONTROL INTERFACE

- A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
 - 1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.
- B. Control circuits shall be 120 VAC or 24 VAC or 24 VDC.
 - 1. 120 VAC supplied by CPT in the VFD.
 - a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
 - b. CPT shall have two fuses on the primary side and one fuse on the secondary side.
 - c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
 - 2. 24 VAC or 24 VDC supplied by Class 2 power supply in the VFD.
 - a. Power supply shall have minimum additional capacity of 33 PCT greater than that required by control devices.
 - b. Provide two current-limiting fuses on the AC supply to the power supply.
 - c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.
- C. Operator Interface:
 - 1. Door mounted sealed keypad, membrane type with LED or LCD display.
 - a. Messages shall be in English and engineering units.
 - b. Drive operating parameters shall be programmable.
 - c. Menu driven.
 - d. Password security.
 - e. Display fault and diagnostic data.
 - f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
 - g. Gold plated plug-in contacts.

2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
 - a. Minimum indications:
 - 1) Run.
 - 2) Stop.
 - 3) Ready.
 - 4) Alarm.
 - 5) Fault.
 - 6) Local control.
 - 7) Remote control.
 - 8) Control source local.
 - 9) Control source remote.
 - 10) Speed indication.
 - b. Minimum control functions:
 - 1) Local/Remote switch.
 - 2) Stop button.
 - 3) Start button.
 - 4) Reset button.
 - 5) Speed control buttons.
3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
 - a. On occurrence of more than one condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:

1. Local portable computer interface via RS232/RS242 serial communications port:
 - a. Capability to:
 - 1) Start-Stop VFD.
 - 2) Control VFD Speed.
 - 3) Access fault and diagnostic data.
2. Analog and discrete inputs:
 - a. Speed reference (setpoint) signal 4-20 mA DC.
 - b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mADC process variable signal.
3. Analog and discrete outputs:
 - a. 4-20 mADC output for remote speed indication, as a function of frequency, calibrated 0 to 100 PCT.
 - b. Drive FAULT contacts.
 - c. Drive RUNNING contacts.
 - d. Drive selector switch in AUTO status contacts.
4. Contacts:
 - a. Contacts shall be rated 2 A inductive at 120 VAC.
 - b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
 - a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
 - b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
 - c. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.
6. Network communications capability: None.

2.5 HARMONIC PROTECTION REQUIREMENTS

- A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.

- B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from either or both the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
 - 1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
 - 2. Current distortion: IEEE 519 Table 10.3 based on $I_{SC}/I_L < 20$.
- C. PCC shall be considered:
 - 1. Building service entrance transfer switch, switchboard or panelboard.
- D. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.
- E. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.
 - 1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
 - 2. Power system data for analysis shall be taken from the electrical drawings and approved equipment submittals.
 - 3. VFD manufacturer shall request from Engineer specific information required to complete the harmonic analysis.
 - 4. VFDs provided in a package with equipment specified elsewhere shall be included in the analysis.

2.6 MOTOR PROTECTION REQUIREMENTS

- A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.
- B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.
- C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.
 - 1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:
 - a. Inverter duty motors: 1280 V.
 - b. Standard motors: 800 V.
 - c. Rise time shall be greater than or equal to 0.1 microsecond.
 - d. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.
- D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10 PCT shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
 - 1. Values in excess of specified limits require correction by contractor and re-measurement.
 - 2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.7 EQUIPMENT CONSTRUCTION

- A. Fabrication and Assembly:
 - 1. Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
 - a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
 - b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.

2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.
 3. Cooling fans, as required, shall be provided to run when drive is running.
 4. Enclosures for separately mounted VFD's:
 - a. NEMA Type 1 for installation in Electrical Rooms.
 - b. NEMA Type 12 for installation in other unclassified areas.
 - c. NEMA Type 4X stainless steel for installations in wet, damp or outdoor areas.
 - 1) Provide enclosure cooling required to not exceed drive temperature ratings.
- B. Wiring:
1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
 - a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
 - b. Bases with a self-sticking back will not be allowed.
 2. All plug-in contacts shall be gold-plated.
 3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
 - a. Provide terminals for shield continuity where required.
 4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
 - a. Non-brittle, interlocking, track-mounted type.
 - b. Screw terminals will not be allowed.
 - c. A terminal for each conductor of external circuits plus one ground for each shielded cable.
 - d. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
 - e. Not less than 25 PCT spare terminals shall be provided.
 - f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal drawings.
 - g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
 5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
 - a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
 6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
 - a. Markings or color code shall match the manufacturer's drawings.
 7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.
- C. Nameplates:
1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10 14 00.
 2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
 3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.
- D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.8 COMPONENTS AND ACCESSORIES

A. Reactors:

1. Impedance: 3 PCT minimum.
2. Continuous current: Not less than drive rating.
3. Current overload: 150 PCT for 1 minute.
4. Insulation temperature rating: 180 DEGC.
5. Copper windings.
6. Saturation current rating: 3.5 to 5 times rated current.
7. Hi-potential rating: 2500 VAC line to ground and line to line, for 1 minute.
8. Noise reduction features:
 - a. Epoxy over cast coil.
 - b. Extra dips and bakes of varnish over continuous wound coil.

2.9 SOURCE QUALITY CONTROL

- A. Factory Tests:
 1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.

2.10 MAINTENANCE MATERIALS

- A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).
- B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.
- B. Provide separately mounted VFD enclosure with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 1. Determine the SCCR rating by one of the following methods:
 - a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
 3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.
- C. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.
- D. Provide services of manufacturer's representative to perform start-up services.
- E. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
 1. The space available on the Drawings shall not be exceeded.

3.2 START UP

- A. Pre-start-up Services:
 1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period described in Specification Section 01 75 00.
 2. Shall consist of:
 - a. Physical and electrical installation check.
 - b. Final adjustments and calibration of drive parameters.
 - c. VFD operation from simulated input signals.

3. Shall be complete when VFD(s) are fully operational.
- B. Field Quality Control:
1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
 - a. For each individual VFD.
 - b. For the maximum number of VFDs that will be operational at the same time.
 - c. When all loads are at 75 PCT load minimum.
 - d. Duration: 1 HR minimum.
 2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
 - a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
 - 1) Time shall be measured in microseconds.
 - b. Tests shall be performed at full:
 - 1) Full voltage and speed.
 - 2) Loaded to 75 PCT minimum.
 - 3) Duration: 1 HR minimum.
 3. Record all data necessary for the preparation of required test reports.
- C. Start-up and Demonstration Services:
1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
 - a. Perform all work in the presence of the Owner's designated representatives.
 2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
 3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
 - a. Ensure compatibility of VFD with associated control and instrumentation signals.
 4. Simulate VFD failures and demonstrate troubleshooting aids.
- D. Instruct Owner's designated personnel:
1. Minimum of 8 HRS at the jobsite.
 2. Include both field and classroom instruction.
 3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
 - a. Lubrication.
 - b. Troubleshooting.
 - c. Repair and replacement.
 - d. Parts inventory.
 - e. Maintenance records.

END OF SECTION

SECTION 26 32 14
ENGINE GENERATOR - DIESEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Engine generator set and accessories.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 48 - Seismic Bracing Systems.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American National Standards Institute (ANSI):
 - a. S1.4, Specification for Sound Level Meters.
 - 2. Environmental Protection Agency (EPA):
 - a. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. MG 1, Motors and Generators.
 - 4. National Fire Protection association (NFPA):
 - a. 70, National Electrical Code (NEC):
 - 1) Article 700, Emergency Systems.
 - 2) Article 701, Legally Required Standby Systems.
 - 3) Article 702, Optional Standby Systems.
 - 5. Underwriters Laboratories, Inc. (UL):
 - a. 2200, Standard for Stationary Engine Generator Assemblies.
- B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and installation of the unit.

1.3 SYSTEM DESCRIPTION

- A. The engine generators will be used and rated for:
 - 1. Optional standby power during a utility power outage, NFPA 70, Article 702.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. See Specification Section 26 05 00 for additional requirements.
 - c. Engine/generator performance curves.
 - 3. Fabrication and/or layout drawings.
 - a. Dimensional plan and elevation drawings.
 - b. Wire interconnection drawings.

- 4. Seismic qualified drawings and certification.
 - a. Seismic certification compliance reports.
- 5. Test reports:
 - a. Factory test reports.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. Unit installation, startup and operational statement.
 - 2. Field Quality Control test reports.

1.5 SITE CONDITIONS

- A. Ambient air temperature:
 - 1. Minimum: 0 DEGF.
 - 2. Maximum: 105 DEGF.
- B. Altitude: 150 FT above sea level.
- C. Seismic (Earthquake) forces:
 - 1. See Specification Section 26 05 48.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Engine generator unit:
 - a. Cummins Onan.
 - 2. Silencers:
 - a. Maxim.
 - b. GT Exhaust Systems.
 - c. Nelson.
 - d. Cowl.
 - e. Hapco.
 - 3. Battery charger:
 - a. Manufacturer's standard.
 - 4. Governor:
 - a. Manufacturer's standard.
 - 5. Radiator:
 - a. Manufacturer's standard.
 - 6. Vibration isolators:
 - a. Caldyne.
 - b. Mason Inds.
 - c. Ace.
 - d. Korfund Dynamics.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 EQUIPMENT

- A. Emissions Requirements:
 - 1. A single unit emissions shall meet all Federal, State and Local government requirements, including but not limited to:
 - a. Environmental Protection Agencies (EPA) New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart IIII.

- B. Performance and Configuration Requirements:
 - 1. Standby power generator.
 - 2. Minimum rated output: 150 kW, 188 kVA at 0.8 pf.
 - 3. Frequency: 60Hz.
 - 4. Voltage: 480Y/277V, 3-phase, 4-wire.
 - 5. Rated speed: 1800 RPM.

2.3 COMPONENTS

- A. Engine Generator Unit General:
 - 1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.
 - 2. Mount unit on skid suitable for installation on concrete foundation.
 - 3. Base rating on operation at rated RPM when equipped with all operating accessories.
 - 4. Standards: UL 2200.
- B. Engine:
 - 1. Four-cycle, full compression ignition, single acting, solid-injection unit, either vertical or V-type pistons naturally aspirated or turbo charged with after cooling.
 - 2. Fuel supply: No. 2 Diesel.
 - 3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
 - 4. Capable of operating at idle or light loads for extended periods of time.
- C. Injection Pumps and Valves:
 - 1. Type not requiring adjustment in service, which may be individually removed and replaced.
 - 2. Individual injection pump and valve for each cylinder.
 - 3. Fuel injection pumps: Positive action, constant-stroke, actuated by cam driven by gears from engine crankshaft.
 - 4. Fuel lines between injection pumps and valves: Heavy seamless steel tubing.
 - 5. Flexible fuel line connectors for supply and return connections at pump.
- D. Oil Pump:
 - 1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
 - 2. Spray cool and lubricate pistons.
 - 3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
 - 4. Filter elements accessible and easily removable.
 - 5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
 - 6. Equip filter system with spring-loaded by-pass valve.
 - 7. Oil cooler: Water-cooled, engine-mounted.
- E. Fuel System:
 - 1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump, capable of supplying fuel at constant pressure against head of 12 FT.
 - 2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
 - 3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
 - 4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.
- F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 PCT of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.
- G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.
- H. Electric Starting System:

1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
 2. Controls to provide automatic cranking of engine when generator is called to start.
 3. Prevent excessive cranking which could damage cranking motor.
 4. Automatic stop controls.
 5. Starter motors with positive-engagement feature.
- I. Cooling System:
1. Capacity for cooling engine at the specified operating conditions.
 2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
 3. Unit mounted radiator.
 - a. Core guard flexible duct adapter.
 - b. Site glass at top of unit.
 - c. Engine driven blower fan.
 - d. Low water level cutoff switch.
 4. Provide fan guards.
- J. Heater:
1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
 2. 240 VAC, single phase.
- K. Silencer:
1. Suitable type for critical silencing.
 2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.
- L. Engine Instruments and Controls:
1. Engine-mounted instruments:
 - a. Oil pressure gage.
 - b. Water temperature gage.
 - c. Run time meter.
 - d. Battery voltage meter.
 2. Automatic cycle cranking and over-crank protection.
 3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
 4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.
 5. Three NO auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.
 - a. Contacts shall close when generator is started.
- M. Sub-Base Fuel Tank:
1. Double wall sub-base day tank mounted underneath engine generator unit.
 2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.
 3. Tank connections: Fuel level gauge, fuel lines to generator, fill, vent, drain and pressure relief.
 4. Manual overfill protection.
 5. Low level warning with contacts for remote alarm.
 - a. Set to alarm at 50 PCT of capacity.
 6. Critical low level shutoff with contacts for remote alarm.
 7. Leak detection alarm with contacts for remote alarm.
 8. Minimum capacity: 737 GAL.
- N. Batteries:

1. Lead acid type.
 2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.
- O. Battery Charger:
1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
 2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 VAC input.
 3. Malfunction alarm contacts (minimum): low and high battery voltage, weak battery and charger failure.
- P. Generator:
1. Brushless, 4-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
 2. Minimum continuous standby ratings:
 - a. Specified herein, substantiated by manufacturer's standard published curves and conform to NEMA MG 1 specification.
 - b. Special ratings or maximum ratings are not acceptable.
 3. Rated to serve up to 50 PCT non-linear load without exceeding rated temperature rise.
 4. Minimum efficiency: 92 PCT at 50 to 110 PCT of nominal standby rating, less than 30 PCT instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other future units connected in parallel.
 5. Stator and rotor: 130 DEGC temperature rise with minimum Class H insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
 6. Directly connect stator to engine flywheel housing.
 7. Drive rotor through semiflexible driving flange to ensure permanent alignment.
 8. Self-ventilating with suitable blower, air inlet and outlet openings.
 9. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
 10. Generator drive free from critical torsional vibration within operating range.
 11. Provide generator mounted main circuit breaker and load bank circuit breaker:
 - a. Solid state molded case type.
 - b. Ratings as indicated on the Drawings.
- Q. Voltage Regulator:
1. SCR type, to maintain 2 PCT voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 PCT including cross-current compensation to provide maximum of 5 PCT unbalance in kVA load sharing between this unit and possible future generators.
 2. Automatic protection against short circuits on system.
 3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
 4. Provide voltage level and gain controls for normal operating adjustments.
 5. Provide voltage level control with minimum range of plus or minus 5 PCT from rated voltage.
 6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.
- R. Generator Instruments and Controls:
1. Generator mounted NEMA 1 type, illuminated vibration isolated instrument and control panel(s).
 2. AC voltmeter and phase selector switch.
 3. AC ammeter and phase selector switch.
 4. Frequency meter.
 5. Run-off-auto engine, start-stop control switch.
 6. Emergency stop.
 7. Run time meter.
 8. Governor control rheostat.

9. Voltage level adjustment rheostat.
 10. Cool down time delay 0-15 minute adjustable.
 11. Cycle cranking control.
 12. Minimum red shut down indicating lights as follows:
 - a. Overcrank.
 - b. Overspeed.
 - c. Low lubricating oil pressure.
 - d. High engine water temperature.
 13. Minimum amber alarm indicator lights as follows:
 - a. Control switch not in auto position.
 - b. Low engine water temperature (less than 70 DEGF).
 - c. Low fuel in day tank.
 - d. Day tank leak.
 - e. Battery charger malfunctioning.
 - f. Low battery voltage.
 14. Minimum amber prealarm indicator lights as follows:
 - a. High engine water temperature.
 - b. Low lubricating oil pressure.
 15. Dry relay contacts for remote monitoring of the following conditions:
 - a. Not in Auto.
 - b. Running.
 - c. Warning.
 - d. General Alarm.
 - e. Diesel Fuel Level Low.
- S. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

2.4 ACCESSORIES

- A. Provide interposing relays (24 VDC to 120 VAC) as required for interfacing with customer's 120 Vac monitoring system.
- B. Generator set non-walk-in weather protective enclosure:
 1. Sound attenuation:
 - a. Level 1: 80 dB(A) at 7 meters under full load operation.
 2. Sheet steel with side servicing panels, air intake louvers and rear control panel access door.
 3. Side servicing panels shall have two locking points; all panels and doors are key lockable.
 4. Pitched roof with silencing exhaust muffler mounted inside the enclosure.
 5. Completely install enclosure on generator set mounting base.
 6. Stainless steel hardware.
 7. Non-hydroscopic sound insulation.
 8. Rodent barriers.
 9. Enclosure mounted directly to a sub-base fuel tank.
 10. Exterior oil and coolant drains with interior valves.

2.5 SOURCE QUALITY CONTROL

- A. Individually test each prime mover.
 1. Apply derating factors for the proposed site to test data.
 2. Continuously test for a period no less than 2 HRS.
 3. Test procedure shall be as follows:
 - a. Start prime mover and upon reaching rated RPM, pick up 100 PCT of nameplate KW rating at rated power factor in one step.
 - b. Observe and record the cranking time(s) required to start and run for each prime mover.

- c. Observe and record the time required to come up to operating speed for each prime mover.
- d. Record voltage and frequency overshoot for each prime mover.
- e. Record voltage, frequency and amperes.
- f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

2.6 MAINTENANCE MATERIALS

A. Spare Parts:

1. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

ITEM	QUANTITY
Diesel fuel line filter elements	3 complete sets
Lubricating oil filter elements with gasket	3 complete sets
Air cleaner filter element	1 complete set
Auxiliary fuel and jacket water pump packing/seals	1 complete set
Cooling fan drive belt (if applicable)	2 complete sets
Hydrometer	1 each
Two-pronged battery voltmeter	1 each
Special tools required to maintain or dismantle engine generator set	1 complete set
Spare fuses, if used in the control panel	1 complete set
Spare indicating lamps	4 each type used

2. Provide a spare parts list with associated costs which includes, but is not limited to the following:
 - a. Fuel oil filter element and gasket.
 - b. Lubricating oil filter element and gasket.
 - c. Air cleaner filter element.
 - d. Packing set for each auxiliary pump.
 - e. V-belts for fan and pump drives.
3. Accessories:
 - a. Universal General Purpose Spill Kit
 - b. Manufacturer:
 - 1) Interstate Products - Model GPSK30, or equal
 - c. Design and Fabrication (minimum requirements):
 - 1) Absorbent pads: 50
 - 2) Absorbent socks: 6
 - 3) Absorbent pillows: 4
 - 4) Goggles: 1
 - 5) Gloves: 1
 - 6) Disposable bag: 1
 - 7) 30 Gallon Poly Drum with Lid suitable for outdoor storage: 1

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions and Specification Section 26 05 48.
- B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DEGF.

- C. Provide fuel for a full sub-base fuel tank.
- D. Install all wiring to engine in conduit.
 - 1. Control wiring on engine may be factory installed in high temperature loom.
- E. Mount on concrete pad utilizing vibration/seismic isolators, see structural drawings for pad detail.

3.2 FIELD QUALITY CONTROL

- A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
 - 1. Inspect equipment covered by this Specification Section.
 - 2. Supervise pre-startup adjustments and installation checks.
 - 3. Conduct initial startup of equipment and perform operational checks.
 - 4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
 - 5. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.
- B. Provide two load tests and one cycle crank test.
 - 1. Tests one and two shall be for continuous period of no less than 2 HRS each.
 - 2. Engineer and Owner shall be notified seven days prior to testing.
 - 3. Test number one:
 - a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
 - b. Observe and record the time delay on engine start.
 - c. Observe and record the cranking time(s) required to start and run for each prime mover.
 - d. Observe and record the time required to come up to operating speed for each prime mover.
 - e. Record voltage and frequency overshoot for each prime mover.
 - f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.
 - g. Record voltage, frequency and amperes.
 - h. Record oil pressure, water temperature where applicable and battery charge rate at 5-minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.
 - i. Return normal power to facility, record time delay on retransfer to normal for each switch and cooldown time delay for each prime mover.
 - 4. Test number two:
 - a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100 PCT of nameplate KW rating in one step.
 - 1) Unity power factor is acceptable for on-site testing
 - b. Observe and record the cranking time(s) required to start and run for each prime mover.
 - c. Observe and record the time required to come up to operating speed for each prime mover.
 - d. Record voltage and frequency overshoot for each prime mover.
 - e. Observe and record time required to achieve steady-state condition.
 - f. Record voltage, frequency and amperes.
 - g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.
 - 5. Cycle crank test:
 - a. Perform test for each prime mover.
 - 1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.
 - 2) Put control switch into "run" position to cause prime mover to crank.
 - b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.

- 1) Upon starting and running of the prime mover, further cranking shall cease.
- 2) Two means of cranking termination shall be utilized so that one will act as a backup to the other to prevent inadvertent starter engagement.
- 3) Cranking limiter time shall be 75 seconds for cycle crank.
6. Furnish load banks of required ratings necessary for tests.
7. Record engine fuel consumption by means of test equipment.
8. Test all safeties specified for generator instruments and controls as recommended by manufacturer and as required to verify proper operation.
9. The Contractor shall be responsible for fuel and all consumables use during the test.

END OF SECTION

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SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Automatic transfer switches.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.
 - 4. Section 26 05 48 - Seismic Bracing Systems.
 - 5. Section 26 43 13 – Low Voltage Surge Protection Devices (SPD).

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 98, Standard for Safety Enclosed and Dead-Front Switches.
 - b. 1008, Standard for Safety Switch Equipment.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification:
 - b. See Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings.
 - 4. Seismic qualified drawings and certification.
 - a. Seismic certification compliance reports.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
 - 1. Automatic transfer switches:
 - a. Automatic Switch Company.
 - b. Kohler.
 - c. Onan.

- d. Russelectric.
- e. Zenith Products.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 AUTOMATIC TRANSFER SWITCH

A. Construction:

1. Suitable for use as Service Equipment.
2. Provide transfer switch mounted main circuit breaker:
 - a. Solid state molded case type.
 - b. Ratings as indicated on the Drawings.
3. Electrically operated mechanically held, double throw, air-break type.
4. Silver-surface main contacts and protect by arcing contacts.
5. Switch shall have provisions for visual inspection of switch blades and contacts.
6. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
7. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.
8. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
9. Ratings:
 - a. Continuous duty in both normal and emergency.
 - b. Three-phase, three-pole, four-wire.
 - c. Voltage and current ratings as indicated on the Drawings.
 - d. Short circuit withstand rating equal to or greater than the normal source electrical gear.
10. Standards: UL 1008.

B. Operation:

1. Microprocessor based control module.
2. Open transition.
3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
 - a. Normal source voltage sensing.
 - 1) Adjustable pickup from 85-100 PCT of rated voltage, factory set 90 PCT.
 - 2) Adjustable dropout from 75-98 PCT of pickup setting, factory set 85 PCT.
 - b. Emergency source voltage and frequency sensing:
 - 1) Adjustable pickup from 85-100 PCT of rated voltage, factory set 90 PCT.
 - 2) Fixed voltage dropout at 85 PCT of pickup setting.
 - 3) Adjustable pickup from 90-100 PCT of rated frequency, factory set 95 PCT.
 - 4) Fixed frequency dropout at 88 PCT of pickup setting.
6. Time delays:
 - a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
 - b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
 - c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
 - 1) Automatically bypassed when emergency source fails and normal source is available.
 - d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
 - a. Enable and disable function.

- b. Selectable to exercise with or without transferring load.
 - c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
 - d. Adjustable day of the week exercise setting, factory set for Monday.
- 8. In-phase monitor:
 - a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
 - b. In-phase transfer accomplished if both sources are within 2 Hz of rated frequency and 70 PCT or more of rated voltage.
- C. Overcurrent and Short Circuit Protective Devices:
 - 1. Main overcurrent protective device:
 - a. Molded case circuit breaker.
 - 2. Branch overcurrent protective devices:
 - a. Molded case circuit breaker.
 - 3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
 - 4. Factory installed.
- D. Integral surge protective device:
 - 1. Provide for each panelboard.
 - 2. Provide Type 1 SPD.
 - 3. See Specification Section 26 43 13.
- E. Enclosure:
 - 1. Dead-front enclosure.
 - 2. NEMA 4 rated.
 - 3. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
 - 4. No knockouts, hinged and lockable door.
- F. Hatchery control system and standby generator interface:
 - 1. Discrete outputs in the form of Form C dry, relay output contacts:
 - a. Utility Power Available.
 - b. ATS in Normal Position.
 - c. Standby Power Available.
 - d. ATS in Standby Position.
 - e. Generator Run Command.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
- B. Connect as indicated in one-line diagram.
- C. Mounting of manual transfer switches: Wall-mounted.
- D. Mounting of automatic transfer switches:
 - 1. Wall-mounted or floor mounted on 4 IN high concrete pad.
- E. Equipment Marking and Documentation:
 - 1. Provide labeling per NFPA 70 and other applicable codes.
 - 2. Service equipment:
 - a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
 - b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
 - 3. Other than service equipment:

- a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
 - b. Available fault current label. (Ref. NFPA 70 Article 408.6)
4. Identify (tag) all equipment and equipment components.
5. Provide labels and tags in accordance with Section 10 14 00.
6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

3.2 FIELD QUALITY CONTROL

- A. Automatic Transfer Switch Testing:
 1. Simulate power outage by opening normal source overcurrent device.
 - a. Verify engine generator starts and switch transfers in the specified time.
 2. Close normal source overcurrent device to simulate the return of normal power.
 - a. Verify the switch retransfers and engine generator shuts down in the specified time.
 3. Perform a manual transfer and retransfer.
 4. Verify the indicator lights function properly.

END OF SECTION

SECTION 26 43 13
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type 1 SPD - High exposure locations (transfer switches or switchboards), integrally mounted.
 - 2. Type 3 SPD - Medium exposure locations (panelboards), integrally mounted.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
 - c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 - d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
 - 2. Military Standard:
 - a. MIL-STD-220B, Method of Insertion Loss Measurement.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 5. Underwriters Laboratories, Inc. (UL):
 - a. 1283, Standard for Electromagnetic Interference Filters.
 - b. 1449, Standard for Surge Protective Devices.
- B. Qualifications:
 - 1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
 - a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

- A. Clamping Voltage:
 - 1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.
 - 2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.
- B. Let-Through Voltage:
 - 1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.

2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.
- C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.
- D. Maximum Surge Current:
1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 PCT deviation of clamping voltage at a specified surge current.
 2. Listed by mode, since number and type of components in any SPD may vary by mode.
- E. MCC: Motor Control Center.
- F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).
- G. Surge Current per Phase:
1. The per phase rating is the total surge current capacity connected to a given phase conductor.
 - a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
 - b. The N-G mode is not included in the per phase calculation.
- H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Manufacturer's qualifications.
 - b. Standard catalog cut sheet.
 - c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
 - d. Testing procedures and testing equipment data.
 - e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
 - 1) Data in the Product Data Sheet heading:
 - a) SPD Type Number per PART 2 of the Specification.
 - b) Manufacturer's Name.
 - c) Product model number.
 - 2) Data in the Product Data Sheet body:
 - a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
 - b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
 - c) Name of the nationally recognized testing laboratory that preformed the tests.
 - d) Warranty information.
 - 3) Data in the Product Data Sheet closing:
 - a) Signature of the manufacturer's official (printed and signed).
 - b) Title of the official.
 - 4) Date of signature.

- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of submittal process.
 - b. The content of the Operation and Maintenance Manuals.
 - 2. Warranty.

1.5 WARRANTY

- A. Minimum of a five year 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.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE 1 SPD

- A. Product:
 - 1. Integrally mounted in switchboards or transfer switches.
 - 2. Hybrid solid-state high performance suppression system.
 - a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
 - 3. Do not connect multiple SPD modules in series to achieve the specified performance.
 - 4. Designed for parallel connection.
 - 5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
 - 6. Device monitor:
 - a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
 - b. A fuse status only monitor system is not acceptable.
- B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.
- C. Modes of Protection: All modes.
 - 1. Three phase (delta): L-L, L-G.
 - 2. Three phase (wye): L-N, L-L, L-G and N-G.
 - 3. Single phase (2-pole): L-L, L-N, L-G and N-G.
 - 4. Single phase: L-N, L-G and N-G.
- D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.
- E. Operating Frequency: 45 to 65 Hz.
- F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.
- G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.
- H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 PCT deviation of the clamping voltage.
- I. SPD Protection:
 - 1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
 - 2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

- J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		C High V & I Wave	B Combination Wave	
L-L < 250 V L-N < 150 V	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V L-N > 150 V	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

- K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 TYPE 3 SPD

- A. Product:
1. Integrally mounted in a panelboard.
 2. Hybrid solid state high performance suppression system.
 - a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
 3. Do not connect multiple SPD modules in series to achieve the specified performance.
 4. Designed for parallel connection.
 5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
 6. Device monitor:
 - a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
 - b. A fuse status only monitor system is not acceptable.
- B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.
- C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
 2. Three phase (wye): L-N, L-L, L-G and N-G.
 3. Single phase (2 pole): L-L, L-N, L-G and N-G.
 4. Single phase: L-N, L-G and N-G.
- D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.
- E. Operating Frequency: 45 to 65 Hz.
- F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.
- G. Maximum Surge Current: 160,000 A per phase, 80,000 A per mode minimum.
- H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 PCT deviation of the clamping voltage.

- I. SPD Protection:
 1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
 2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.
- J. Maximum Clamping Voltages: Dynamic test at the 90 DEG phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		B Comb. Wave	B3 Ring Wave	
L-L < 250 V L-N < 150 V	L-L	1000 V	700 V	800 V
	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V L-N > 150 V	L-L	2000 V	1400 V	1800 V
	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

- K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.4 SOURCE QUALITY CONTROL

- A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.
- B. The SPD are to be tested as a complete SPD system including:
 1. Integral unit level and/or component level fusing.
 2. Neutral and ground shall not be bonded during testing.
 3. 6 IN lead lengths.
 4. Integral disconnect switch when provided.
- C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.
- D. Tests to be performed in accordance with IEEE C62.45:
 1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
 2. Single pulse surge current capacity test.
 3. Repetitive surge current capacity testing.
 4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Type 1 and 3 SPD:
 1. Connected in parallel to the equipment.
 2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
 3. Provide leads that are as short and straight as possible.

4. Maximum lead length: 12 IN.
5. Minimum lead size: #2 stranded AWG or bus bar.
6. Connect leads to the equipment to be protected by one of the following means:
 - a. Through a circuit breaker or molded case switch mounted in the equipment.
 - b. Use manufacturer recommended circuit breaker size.
 - c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

END OF SECTION

SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Interior building and exterior building mounted luminaires.
 - b. Exterior and site luminaires.
 - c. LEDs.
 - d. Drivers.
 - e. Light poles.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Division 03 - Concrete.
 - 4. Section 26 05 00 - Electrical - Basic Requirements.
 - 5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American National Standards Institute (ANSI):
 - a. C78.377, Specification for the Chromaticity of Solid State Lighting Products.
 - 2. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
 - 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 4. Illuminating Engineering Society of North America (IESNA):
 - a. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
 - b. LM-80, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
 - 5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
 - c. LE 4, Recessed Luminaires, Ceiling Compatibility.
 - 6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. SSL 1, Electronic Drivers for LED Devices, Arrays or Systems.
 - 7. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 101, Life Safety Code.
 - 8. Underwriters Laboratories, Inc. (UL):
 - a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
 - b. 924, Standard for Emergency Lighting and Power Equipment.
 - c. 1012, Power Units Other Than Class 2.
 - d. 1310, Standard for Class 2 Power Units.
 - e. 1598, Luminaires.
 - f. 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

9. United States Department of Energy (USDOE):
 - a. EAct, the National Energy Policy Act.

1.3 DEFINITIONS

- A. Useful Life for LED luminaire light sources:
 1. The operating hours before reaching 70 PCT of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
 2. This is also known as 70 PCT "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section.
 - b. Identify luminaire by Luminaire Schedule designation.
 - c. Luminaire data sheet:
 - 1) Name of manufacturer.
 - 2) Complete order information (catalog number).
 - 3) Description of construction and optics.
 - 4) Total input wattage.
 - 5) Luminous efficacy (lumens/Watt).
 - 6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
 - 7) Dimensional size.
 - 8) Weight.
 - 9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
 - 10) Effective Projected Areas (EPA) for pole mounted luminaires.
 - d. Solid state Luminaire additional data:
 - 1) Voltage.
 - 2) Initial and IES L70 lumens.
 - 3) Luminous efficacy (lumens/Watt).
 - 4) Correlated Color Temperature (CCT).
 - 5) Color Rendering Index (CRI).
 - 6) Total Harmonic Distortion (THD).
 - 7) Lamp life.
 - 8) Driver manufacturer and model number.
 - 9) Driver life.
 - 10) Driver type (0-10V, constant voltage, constant current).
 - 11) Dimming range and control device compatibility.
 - 12) Remote driver: Maximum wire length to luminaire.
 - 13) Emergency battery driver:
 - a) Compatibility with lighting module.
 - b) Lumen output of lighting module in emergency operation.
 - c) Battery life.
 - d) Description of testing.
 - e) Ambient operating temperature.
 - 14) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
 - 15) DesignLights Consortium (DLC) Listing.
 - 16) Warranty information.
 - e. Pole data sheet:
 - 1) Name of manufacturer.
 - 2) Complete order information (catalog number).

- 3) Description of construction.
 - 4) Length, shaft size and thickness.
 - 5) Wind loading (available luminaire EPA per wind speed).
 - 6) Anchor bolt template.
 - 7) Bolt size and material.
- f. See Specification Section 26 05 00 for additional requirements.
- 3. Test Reports:
 - a. IESNA LM-79 Test Report for Solid-State Luminaire.
 - b. IESNA LM-80 Test Report Solid-State Light Source.
- 4. Certifications: Solid-state Luminaire Useful Life Certificate.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - b. Submittal data for each component covered by warranty.
 - c. Warranty.

1.5 WARRANTY

- A. Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15 PCT of the individual light emitting diodes fail to illuminate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Luminaires: Per Luminaire Schedule, or equal.
 - 2. Solid State Light Sources:
 - a. Cree.
 - b. Xicato.
 - c. Luminaire manufacturer's proprietary system.
 - 3. LED Driver: Luminaire manufacturer's standard.
 - 4. Emergency ballasts:
 - a. Iota Engineering.
 - b. Philips Bodine.
 - 5. Emergency transfer devices: Philips Bodine.
 - 6. Poles: Luminaire manufacturer's standard.

2.2 GENERAL REQUIREMENTS

- A. Luminaires complete with LED modules and drivers.
- B. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
 - 1. Provide recessed luminaires with trim gaskets cemented in proper position.
- C. Provide standard plaster frame for all recessed luminaires installed in plaster walls or ceilings.
 - 1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.
- D. Coordinate luminaire mounting where recessed into building canopies prior to Submitting Shop Drawings. Confirm clearances and luminaire flange compatibility with construction.
- E. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.
- F. No live parts normally exposed to contact.

- G. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."
- H. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

2.3 LUMINAIRES

- A. Standards and Listings:
 - 1. DesignLights Consortium (DLC).
 - 2. UL 1598.
 - 3. NEMA LE 4 for recessed locations.
- B. Housings:
 - 1. As indicated in the Luminaire Schedule and the following:
 - a. Troffer luminaires:
 - 1) Minimum 22 gage sheet steel.
 - 2) Integral end plates and trim flanges to suit ceiling construction.
 - 3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
 - b. Down Light luminaires:
 - 1) Minimum 22 gage sheet steel, or minimum 16 gage sheet aluminum, unless noted otherwise.
 - 2) Auxiliary junction box secured to mounting frame.
 - c. Extruded aluminum housings, where scheduled, shall be at least 1/8 IN thick.
 - d. Punch and form housings prior to finishing (post-paint).
- C. Trim (Recessed Mounted):
 - 1. As indicated in the Luminaire Schedule and the following:
 - a. For square and rectangular luminaires, miter and continuously weld corners.
 - b. Miter perimeter inverted T-Bar angles at corners.
 - c. Do not butt or overlap squared ends.
 - d. Finish joints smooth.
- D. Castings:
 - 1. As indicated in the Luminaire Schedule and the following:
 - a. Uniform quality, free from imperfections affecting strength and appearance.
 - b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.
- E. Fasteners:
 - 1. As indicated in the Luminaire Schedule and the following:
 - a. Aluminum or steel luminaires: Cadmium-plated or an equivalent.
 - b. Stainless steel luminaires: Stainless steel.
 - c. Bronze luminaires: Bronze or stainless steel.
 - d. Non-metallic luminaires: Stainless steel.
- F. Finishes:
 - 1. As indicated in the Luminaire Schedule and the following:
 - a. Painted surfaces:
 - 1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish; acrylic, alkyd, epoxy, polyester or polyurethane.
 - 2) White finishes shall have minimum 85 PCT reflectance.
 - b. Unpainted surfaces:
 - 1) Interior: Clear anodic coating, satin finish.
 - 2) Exterior: Clear anodic coating.

G. Lens/Louver Frames:

1. As indicated in the Luminaire Schedule and the following:
 - a. Extruded aluminum with mitered corners.
 - b. Hinging or other normal motion shall not cause lens or louver to drop out.
 - c. No light leak between frame and housing.

H. Lenses:

1. As Indicated in the Luminaire Schedule and the Following:
 - a. 100 PCT virgin, UV stabilized acrylic.
 - b. Held securely in place but must also be removable for cleaning and servicing.
 - c. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
 - d. No light leaks between the lens and the luminaire.

I. Reflectors:

1. As Indicated in the Luminaire Schedule and the Following:
 - a. Down Light Reflector and Baffle Finishes: First-quality "Alzak" anodized specular finish.
 - b. Troffer reflector finish: Integral reflectors shall be painted white after fabrication with a minimum reflectance value of 90 PCT.

J. Gaskets:

1. As Indicated in the Luminaire Schedule and the Following:
 - a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and which allow interior access.
 - b. Moisture seal gaskets at exterior locations and in other designated wet areas.
 - c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

K. Ventilation:

1. Ventilation openings of adequate size and quantity to permit operation of driver without affecting rated output or life expectancy. Include wire mesh screens.

L. Wiring:

1. Factory-wired to be compatible with the project electrical and controls systems.

M. Mounting Accessories:

1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not affected during servicing or cleaning.
3. Recessed Luminaires:
 - a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
 - b. Baffles and Gaskets: As required to prevent light leakage.
 - c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
4. Luminaire Suspension Material:
 - a. Unfinished Spaces:
 - 1) 1/2 IN minimum diameter swivel stem, unless otherwise noted.
 - 2) Safety chain on high bay type.
 - b. Finished Spaces: Unless otherwise noted.
 - 1) Manufactured cable or stem and outlet box canopy.
 - a) Contemporary design with swivel self-aligning features.
 - b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.
 - c) Finish to match luminaire.

- 2) Coordinate pendant location with ceiling tiles/ceiling grid.
 - a) Submit coordinated mounting accessories as part of Shop Drawing submission.
- 3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.

2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

- A. Standards:
 1. IESNA LM-79, IESNA LM-80.
 2. NEMA SSL 1.
 3. UL 1012, 1310, and 8750.
- B. Solid state modules and driver to be provided and warranted by luminaire manufacturer.
- C. Solid-State Modules:
 1. Uniform color temperature of 4000K unless otherwise noted on the Luminaire schedule.
 - a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
 2. Minimum color rendering index (CRI) of 80 for indoor and 70 for outdoor applications.
 3. LED module light output and efficacy: Measured in accordance with IESNA LM-79 standards.
 4. LED useful life and lumen maintenance: Measured in accordance with IESNA LM-80 standards.
 5. Driver and LED module: Minimum useful life of 50,000 HRS (L70).
 6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.
- D. Driver:
 1. Compatible with solid-state modules and control devices specified.
 2. Operate from 60 Hz input source of 120V through 277V with sustained variations of ± 10 PCT (voltage and frequency).
 3. Input current Total Harmonic Distortion (THD): Less than 20 PCT when operated at nominal line voltage.
 4. Power Factor: Greater than 0.90.
 5. Avoid interference with infrared devices and eliminate visible flicker.
 6. Comply with ANSI C62.41 Category A for Transient protection.
 7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
 8. Dimmable drivers capable of continuous dimming over a range of 100 PCT to 10 PCT of rated lumen output, unless otherwise specified in Luminaire Schedule. Dimming controlled by a 0 - 10 VDC signal, unless otherwise specified in Luminaire Schedule.
 9. Control device must be compatible with type of driver, and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.
 10. Remote-mounting:
 - a. Provide maximum allowable distances for secondary wire runs to luminaires.
 - b. Provide remote mounting hardware and enclosures as required.
 11. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.
- E. Emergency Battery Driver:
 1. UL 924.
 2. Confirm compatibility with LED modules utilized.
 3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry.

4. A solid state charging indicator light to monitor the charger and battery.
5. Single-pole test switch.
6. The following product family shall be selected based on coordination with LED lamp type:
 - a. Philips Bodine "BSL23C": can operate up to 4.5W at 410mA.
 - b. Philips Bodine "BSL26C": can operate up to 5.1W at 265mA.
 - c. Philips Bodine "BSL722 IN": can operate up to 23W at 770mA.
 - d. Philips Bodine "BSL23C": can operate up to 23W at 770mA in operating conditions ranging from -20 DEGC (-4 DEGF) to 60 DEGC (140 DEGF).
 - e. Alternate manufacturer: Iota.
- F. Luminaire properly heat sunk to assure LED junction temperature ratings are not exceeded.
 1. Provide ambient operating temperature range for which product is warranted.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

- A. Standards:
 1. UL 924.
 2. NFPA 101.
 3. Local State or City requirements.
- B. Exit Signs:
 1. Housing and finish: As indicated in the Luminaire Schedule.
 2. LED illuminated with integral driver.
 3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
 4. Battery powered units:
 - a. Battery type: As indicated in the Luminaire Schedule.
 - b. Self-testing/self-diagnostic.
 - 1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
 - c. Consist of batter, charger and electronic circuitry.
 - d. Solid state charging indicator light to monitor the charger and battery.
 - e. Single-pole test switch.
 - f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.
- C. Emergency Lighting Units:
 1. Housing: As indicated in the Luminaire Schedule.
 2. Lamps: As indicated in the Luminaire Schedule.
 3. Battery type: As indicated in the Luminaire Schedule.
 4. Self-testing/self-diagnostic.
 - a. Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
 5. Consist of batter, charger and electronic circuitry.
 6. Solid state charging indicator light to monitor the charger and battery.
 7. Single-pole test switch.
 8. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.
- D. Emergency Circuit Transfer Device:
 1. Transfer device permits emergency lights to be switched under normal conditions and automatically transfers to unswitched emergency circuit upon power interruption.
 2. Multiple luminaire switching:
 - a. Up to 20A.
 - b. Mounting as indicated on the Drawings.
 - c. Acceptable product family:
 - 1) Philips Bodine GTD20A or equal.
 3. Individual luminaire switching:
 - a. Mount on top of luminaire or in ballast channel.

- b. Acceptable product family:
 - 1) Philips Bodine GTD or equal.

2.6 POLES

- A. As Indicated in the Luminaire Schedule and the Following:
 - 1. Designed for attached luminaire EPA with a 100 MPH maximum wind velocity at the base with a 1.3 wind gust factor.
 - 2. Additional features:
 - a. Handhole near base of pole.
 - b. Grounding lug accessible at handhole.
 - c. Galvanized anchor bolts.
 - d. Anchor bolt covers.
 - e. Vibration dampener(s).

2.7 POWER INSTALLED POLE FOUNDATION ANCHORS

2.8 MAINTENANCE MATERIALS

- A. Furnish a minimum of 10 PCT of total of each type and amperage of fuses for fixtures indicated to be fused.
- B. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate Luminaire Types with Ceiling Construction:
 - 1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.
- B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.
- C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.
 - 1. Do not support luminaire from conduit system.
 - 2. When luminaire is supported from outlet boxes, install per NFPA 70.
 - 3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.
- D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.
 - 1. Luminaires up to 4 FT wide and 4 FT long: A minimum of four supporting points, one at each corner.
 - 2. Luminaires 8 FT long: A minimum of five support points, one at center of luminaire and one at each corner.
 - 3. Luminaires smaller than 2 FT in length: A minimum of two supporting points.
- E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.
 - 1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
 - 2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.
 - 3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.
 - a. Chain or cable to prevent luminaire from falling more than 3 IN before the luminaire is caught by the chain or cable.
- F. Pendant Mounted, Open, Industrial Luminaire:
 - 1. Not in continuous rows:
 - a. Supported by conduit or by approved chains or cable:

- b. Hardwired to ceiling mounted junction box.
- 2. In continuous rows:
 - a. Supported rigidly with conduit and fasten luminaire to each other or mount on continuous metal channel per Specification Section 26 05 00.
 - b. Hardwired to ceiling mounted junction box.
 - c. Provide reflector alignment clips.
- G. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
 - 1. Locate luminaires in accordance with reflected ceiling plans.
- H. Locate luminaire in exact center of ceiling tile unless otherwise indicated.
 - 1. Relocate incorrectly installed luminaire and replace damaged ceiling materials.
- I. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicated on the Drawings.
- J. Install exterior luminaires so that water cannot enter or accumulate in the wiring compartment.
- K. Luminaires with Emergency Battery:
 - 1. Where luminaires with emergency battery are shown controlled via switching device, connect the emergency battery to corresponding unswitched circuit so emergency battery will not operate when normal power is available and switching device turns lights off. Upon failure of normal power, luminaire will operate in emergency mode regardless of switch position.
 - 2. Luminaire manufacturer to supply the emergency battery with luminaire.
- L. Ground luminaire.

3.2 POLE INSTALLATION

- A. Drawings Indicate the Intended Location of Light Pole:
 - 1. Field conditions may affect actual location.
 - 2. Coordinate location with all existing or new utilities and pavement.
- B. Anchor Base Plated Poles:
 - 1. Mounted on cast-in-place foundations, as detailed on the Drawings.
 - a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.
 - 2. Protect pole finish during installation.
 - a. Repair damage to pole finish with manufacturer approved repair kit.
- C. Ground poles as indicated on the Drawings.
- D. Conductors:
 - 1. See Specification Section 26 05 19 for required underground conductors.
 - 2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #12 AWG minimum.
- E. Overcurrent and Short Circuit Protection:
 - 1. Protect each phase with a UL Class CC fuse:
 - a. Size: Three times load current.
 - b. Standard: UL 248-4.
 - 2. Fuse holder:
 - a. Watertight, in-line and break-a-way style.
 - b. Accept up to a 30 A, 600 V fuse.
 - c. Neutral conductor shall utilize a fuse holder with a solid copper rod.
 - d. Conductor terminal: Adequate size for the installed conductors.

3.3 LIGHTING CONTROL

- A. See Specification Section 26 09 16 and 26 09 43 for lighting control equipment.
- B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

3.4 ADJUST AND CLEAN

- A. See Specification Section 01 74 00.
- B. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION



DIVISION 31

EARTHWORK



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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site clearing, tree protection, stripping topsoil and demolition.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.
 - 4. Section 31 25 00 - Soil Erosion and Sediment Control.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect existing trees and other vegetation to remain against damage.
 - 1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
 - 2. Avoid foot or vehicular traffic or parking of vehicles within drip line.
 - 3. Provide temporary protection as required.
- B. Repair or replace trees and vegetation damaged by construction operations.
 - 1. Repair to be performed by a qualified tree surgeon/licensed arborist.
 - 2. Remove trees which cannot be repaired and restored to full-growth status.
 - 3. Replace with new trees of minimum 4 IN caliper or as required by local tree ordinance.
- C. Owner will obtain authority for removal and alteration work on adjoining property, as applicable.

3.2 SITE CLEARING

- A. Topsoil Removal:
 - 1. Strip topsoil to depths encountered or as specified within the soils report, 4 IN minimum.
 - a. Remove heavy growths of grass before stripping.
 - b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.
 - c. Separate from underlying subsoil or objectionable material.
 - 2. Stockpile topsoil where directed by Engineer.
 - a. Construct storage piles to freely drain surface water.
 - b. Seed or cover storage piles to prevent erosion.
 - 3. Do not strip topsoil in wooded areas where no change in grade occurs.
 - 4. Borrow topsoil: Reasonably free of subsoil, objects over 2 IN DIA, weeds and roots.
- B. Clearing and Grubbing:
 - 1. Clear from within limits of construction all trees not marked to remain.
 - a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.
 - 2. Grub (remove) from within limits of construction all stumps, roots, root mats, logs and debris encountered.

C. Disposal of Waste Materials:

1. Do not burn combustible materials on site.
2. Remove all non-organic waste materials from site and stockpile organic material where indicated on drawings. Coordinate with Owner.
3. Do not bury organic matter on site.

END OF SECTION

SECTION 31 23 00

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Earthwork - excavation, backfilling, grading, compaction, disposal of waste and surplus materials, placing crushed stone, construction of berms, sheeting, bracing, dewatering and other Earthwork related work.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 07 26 00 - Under Slab Vapor Retarder.
 - 4. Section 31 25 00 - Soil Erosion and Sediment Control.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³).
 - c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT³(2,700 kN-M/M³)).
 - d. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - e. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
 - f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - g. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - h. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 2. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

1.3 DEFINITIONS

- A. Excavation:
 - 1. Consists of removal of material encountered to subgrade elevations required or indicated.
 - 2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.
- B. Foundations: Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.
- C. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.
- D. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.
- E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

- F. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.
- G. Unauthorized Excavation:
 - 1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
 - a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
 - 2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Certifications.
- B. Samples:
 - 1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
 - 2. Test reports.

1.5 PROJECT CONDITIONS

- A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.
- B. Dispose of non-organic waste materials, legally, off site.
 - 1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill and Backfill:
 - 1. Selected material approved by Geotechnical Engineer from site excavation or from off site borrow.
 - 2. Structural Fill:
 - a. May be low volume change cohesive or granular soil at Contractor's option.
 - b. Free of organic matter, frozen material and debris.
 - c. Low volume change cohesive soil:
 - 1) ASTM D2487 classification: CL-ML or CL.
 - 2) Liquid limit: Less than 45.
 - 3) Maximum plasticity index: 20.
 - d. Granular soil:
 - 1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM or SC.
 - 3. Non-Structural Fill:
 - a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
 - b. Liquid limit: Less than 45.
 - c. Maximum plasticity index: 20.
- B. Granular Fill Under Building Floor Slabs-On-Grade, Electrical Equipment Pads, Manholes and Handholes:
 - 1. Clean, granular material.
 - 2. Less than 5 PCT fines passing the No. 200 sieve.

3. ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4 or other material acceptable to Geotechnical Engineer.
- C. Granular Fill Under Electrical Equipment Pads, Manholes and Handholes: Clean, crushed, nonporous rock, crushed or uncrushed gravel complying with ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4.
- D. Geotextile Filter Fabric:
 1. Nonwoven type.
 2. Equivalent opening size: 50 - 100 (U.S. Standard Sieve).
 3. Permeability coefficient (cm/second): 0.07 minimum, 0.30 maximum.
 4. Grab strength: 90 LBS minimum in either direction in accordance with ASTM D4632 requirements.
 5. Mullen burst strength: 125 PSI minimum in accordance with ASTM D3786 requirements.
- E. Vapor Retarder: Refer to Specification Section 07 26 00.
- F. : See Section 03 31 30.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Erosion Control:
 1. See Specification Section 31 25 00.
 2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
 3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
 - a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.
- B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
 1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
 2. Protect and maintain bench marks, monuments or other established reference points and property corners.
 - a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
 3. Verify location of utilities.
 - a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
 - b. Secure and examine local utility records for location data.
 - c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
 - 1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
 - 2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
 - 3) Obtain Owner's approval prior to disconnecting any utility service.
 - d. Repair damages to utility items at own expense.
 - e. In case of damage, notify Engineer at once so required protective measures may be taken.
 4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
 - a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

- b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
 - c. All repairs to be made and paid for by Contractor.
- 5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
- 6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
- 7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

3.2 SITE EXCAVATION AND GRADING

- A. The site excavation and grading work includes the offsite disposition of all material:
 - 1. That exceed quantities required for earthwork on the project.
 - 2. That the Geotechnical engineer classifies as unclassified excavation.
 - 3. That the Geotechnical engineer classifies as unacceptable.
 - 4. That the Geotechnical engineer classifies as potentially contaminated.
- B. Excavation and Grading:
 - 1. Perform as required by the Contract Drawings.
 - 2. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
 - a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
 - b. Perform other layout work required.
 - c. Replace property corner markers to original location if disturbed or destroyed.
 - 3. Preparation of ground surface for embankments or fills:
 - a. Before fill is started, scarify to a minimum depth of 6 IN in all proposed embankment and fill areas.
 - b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.
 - 4. Protection of finish grade:
 - a. During construction, shape and drain embankment and excavations.
 - b. Maintain ditches and drains to provide drainage at all times.
 - c. Protect graded areas against action of elements prior to acceptance of work.
 - d. Reestablish grade where settlement or erosion occurs.
- C. Borrow:
 - 1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
 - 2. Include cost of all borrow material in original proposal.
 - 3. Fill material to be approved by Geotechnical Engineer prior to placement.
- D. Construct embankments and fills as required by the Contract Drawings:
 - 1. Construct embankments and fills at locations and to lines of grade indicated.
 - a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
 - 2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
 - a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
 - b. Do not place material in layers greater than 8 IN loose thickness.
 - c. Place layers horizontally and compact each layer prior to placing additional fill.
 - 3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
 - a. In general, compact cohesive soils by sheep'sfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
 - b. Control moisture for each layer necessary to meet requirements of compaction.

E. Grading Tolerances: 1.0 ±IN.

3.3 USE OF EXPLOSIVES

A. Blasting with any type of explosive is prohibited.

3.4 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Provide dewatering system necessary to successfully complete compaction and construction requirements.

C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.

D. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.

E. Assure by results of testing that compaction densities comply with the following requirements:

1. Sitework:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Paved Areas, Sidewalks and Piping:		
Cohesive soils	95 PCT per ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	75 PCT relative density per ASTM D4253 and ASTM D4254	
Unpaved Areas:		
Cohesive soils	90 PCT of ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	65 PCT relative density per ASTM D4253 and ASTM D4254	

2. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material	98 PCT per ASTM D698	-2 to +3 PCT of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	92 PCT per ASTM D698	-2 to +3 PCT of optimum

3. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	98 PCT per ASTM D698	-2 to +3 PCT of optimum
Under void	85 PCT per ASTM D1557	-2 to +3 PCT of optimum
Granular fill under base slabs with pressure relief valves	75 PCT relative density per ASTM D4253 and ASTM D4254 or 98 PCT of ASTM D698	
Granular fill under building floor slabs-on-grade	60 PCT relative density per ASTM D4253 and ASTM D4254	

3.5 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:

1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
2. Obtain fill and backfill material necessary to produce grades required.
 - a. Materials and source to be approved by Geotechnical Engineer.
 - b. Excavated material approved by Geotechnical Engineer may also be used for fill and backfill.
3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:

1. General:
 - a. Do not commence excavation for foundations for structures until Geotechnical Engineer approves:
 - 1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
 - 2) Density and moisture content of site area compacted fill material meets requirements of specifications.
 - 3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
 - 4) Surcharge or mass fill material has been removed from construction area or portions thereof.
 - b. Engineer grants approval to begin excavations.
2. Dimensions:
 - a. Excavate to elevations and dimensions indicated or specified.
 - b. Allow additional space as required for construction operations and inspection of foundations.
 - c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
 - d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
 - a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Geotechnical Engineer.

- b. Remove unsuitable subgrade soils located below foundations. The bottom of the overexcavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
 - 1) Distance equal to depth of overexcavation below bottom of foundations.
 - 2) 5 FT.
 - 3) As directed by Geotechnical Engineer.
 - c. When excavation has reached required subgrade elevations, notify Geotechnical Engineer, who will make an inspection of conditions.
 - 1) If Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.
- 4. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
 - a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
 - b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 6 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
 - c. Do not carry excavations lower than shown for foundations except as directed by Geotechnical Engineer or Engineer.
 - d. If any part of excavations is carried below required depth without authorization, notify Engineer and correct unauthorized excavation as directed. Corrections may include:
 - 1) Under soil supported footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
 - a) Concrete fill may be used to bring elevations to proper position.
 - 2) In locations other than those above, including slabs on grade and pile supported foundations, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Geotechnical Engineer.
 - 3) No extra compensation will be made to Contractor for correcting unauthorized excavations.
- 5. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
- 6. Notify Geotechnical Engineer and Engineer as soon as excavation is completed in order that subgrades may be inspected.
 - a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Geotechnical Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.
 - b. Geotechnical Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
 - c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
 - d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
- 7. Dewatering:
 - a. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.

- b. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
 - c. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
 - d. Employ dewatering specialist for selecting and operating dewatering system.
 - e. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.
 - f. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
 - 1) Install groundwater monitoring wells as necessary.
 - g. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
8. Subgrade stabilization:
- a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Geotechnical Engineer.
 - b. Provide compaction density of replacement material as stated in this Specification Section.
 - c. Loose, wet, or soft materials, when approved by Geotechnical Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
 - d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
 - e. Remove and replace frozen materials as directed by Geotechnical Engineer.
 - f. Method of stabilization shall be performed as directed by Geotechnical Engineer.
 - g. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Geotechnical Engineer.
9. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.
- a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DEGF before structure is completed and heated to a temperature of at least 50 DEGF.
10. Protection of structures:
- a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
 - b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
11. Shoring:
- a. Shore, slope, or brace excavations as required to prevent them from collapsing.
 - b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
 - c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
12. Drainage:
- a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
 - b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
 - c. Provide pumping required to keep excavated spaces clear of water during construction.
 - d. Should any water be encountered in the excavation, notify Engineer and Geotechnical Engineer.
 - e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.

13. Frost protection:
 - a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
 - b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
 - c. Protect excavation from frost if placing of concrete or fill is delayed.
 - d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.
 - e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.
- C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:
 1. General:
 - a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Geotechnical Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
 - b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 PCT.
 - c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Geotechnical Engineer as being free of undesirable material and compacted to specified density.
 2. Obtain approval of fill and backfill material and source from Geotechnical Engineer prior to placing the material.
 3. Granular fill under floor slabs-on-grade: Place all floor slabs-on-grade on a minimum of 6 IN of granular fill unless otherwise indicated.
 4. Vapor barrier: Install a continuous vapor barrier under floor slabs-on-grade as required by Specification Section 07 26 00 and shown on Contract Drawings.
 5. Fill and backfill placement:
 - a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Geotechnical Engineer.
 - b. Place fill and backfill material in 8 IN lifts.
 - c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
 - d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
 - 2) Contractor is responsible for method of compaction so as not to damage wall.
 - e. Use hand operated equipment for filling and backfilling next to walls.
 - f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
 - g. Use vibratory equipment to compact granular material; do not use water.
 6. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.
- D. Filling and Backfilling Outside of Structures:
 1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
 2. Provide material as approved by Geotechnical Engineer for filling and backfilling outside of structures.
 3. Fill and backfill placement:

- a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Geotechnical Engineer.
- b. Place fill and backfill material to maximum allowable lift thickness indicated in Paragraph 3.5, C, 5, b of this Section.
- c. Compact material with equipment of proper type and size to obtain density specified.
- d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
 - 2) Contractor is responsible for method of compaction so as not to damage wall.
- e. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
- f. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
- g. Use vibratory equipment for compacting granular material; do not use water.
- 4. Backfilling against walls:
 - a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
 - b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
 - c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
 - 1) See Contract Drawings for specific exceptions.
 - d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.
- E. Backfilling Outside of Structures Under Piping or Paving:
 - 1. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Specification Section.
 - 2. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
 - 3. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Specification Sections for the Project.

3.6 FIELD QUALITY CONTROL

- A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA Standards, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.
- B. Special Inspection and Testing:
 - 1. See Section 01 45 33.
- C. Responsibilities of Special Inspector:
 - 1. Review proposed materials for fill and backfill around structures.
 - 2. All testing, observation and work indicated as being performed by the Geotechnical Engineer in this Specification Section .
 - 3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 - 4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 - 5. Extent of compaction testing will be as necessary to assure compliance with specifications.

6. Prepare and submit inspection and test reports to Engineer.
 - a. Coordinate such work with other Special Inspectors.
7. Test reports to include the following:
 - a. Report and certification of aggregate fill and drainage fill.
 - b. Test reports on borrow material.
 - c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
 - d. Field reports; in-place soil density and moisture tests.
 - e. One optimum moisture-maximum density curve for each type of soil encountered.
 - f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
 - h. Assist Engineer to determine corrective measures necessary for defective work.
- D. Responsibilities of Testing Agency for Site Excavation and Grading:
 1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
 2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 4. Extent of compaction testing will be as necessary to assure compliance with specifications.

END OF SECTION

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SECTION 31 23 33
TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Excavation, trenching, backfilling and compacting for all underground utilities.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - 4. Division 26 - Electrical.
 - 5. Section 31 23 00 - Earthwork.
 - 6. Section 33 05 16 - Precast Concrete Manhole Structures.
 - 7. Section 33 05 23 - Pipeline Undercrossings.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³ (600 kN-M/M³)).
 - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - c. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

1.3 DEFINITIONS

- A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
 - 4. Submit sieve analysis reports on all granular materials.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Trench shield (trench box) certification if employed:
 - a. Specific to Project conditions.
 - b. Re-certified if members become distressed.
 - c. Certification by registered professional structural engineer, registered in the state where the Project is located.
 - d. Engineer is not responsible to, and will not, review and approve.

1.5 SITE CONDITIONS

- A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
 - 1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
- C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.
- D. Verify location of existing underground utilities

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Material:
 - 1. As approved by Engineer.
 - a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
 - b. Moisture content at time of placement: ± 3 PCT of optimum moisture content as specified in accordance with ASTM D698.
 - 2. Gravel trench backfill materials:
 - a. Uniformly graded pea gravel defined below:

Sieve Size	1 IN	3/4 IN	3/8 IN	No. 4	No. 20
Percent Passing by Weight	100	75-100	50-80	30 mac	7.0 max

- B. Subgrade Stabilization Materials: Provide subgrade stabilization material consisting of 4 in -8 in quarry spall.
- C. Bedding Materials:
 - 1. As approved by the Geotechnical Engineer.
 - 2. Granular bedding materials:
 - a. ASTM D2321 Class 1B.
 - 1) Well-graded crushed stone.
 - 3. Flowable fill:
 - a. Description: Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head.
 - b. Material characteristics:
 - 1) The approximate quantities of each component per cubic yard of mixed material shall be as follows:
 - a) Cement (Type I or II): 50 LBS.
 - b) Fly ash: 200 LBS.
 - c) Fine sand: 2,700 LBS.
 - d) Water: 420 LBS.
 - e) Air content: 10 PCT.
 - 2) Actual quantities shall be adjusted to provide a yield of 1 cubic yard with the materials used.
 - 3) Approximate compressive strength should be 85 to 175 PSI.
 - 4) Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.
 - 5) Mixing and handling of the material shall be in accordance with Specification Section 03 31 31.

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and dispose of unsuitable materials as directed by Geotechnical Engineer to site provided by.

3.2 EXCAVATION

- A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Geotechnical Engineer.
- B. Excavation for Appurtenances:
 - 1. 12 IN (minimum) clear distance between outer surface and embankment.
 - 2. See Specification Section 31 23 00 for applicable requirements.
 - 3. See Specification Section 33 05 16 for applicable requirements.
- C. Groundwater Dewatering:
 - 1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade to allow pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
 - 2. Groundwater shall be drawn down and maintained at least 3 FT below the bottom of any trench or manhole excavation prior to excavation.
 - 3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
 - a. Employ dewatering specialist for selecting and operating dewatering system.
 - 4. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.
 - 5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
 - 6. Install groundwater monitoring wells as necessary.
 - 7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
 - 8. Cost of groundwater dewatering shall be included in the lineal foot unit price of the pipe installation .
- D. Trench Excavation:
 - 1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
 - a. Support existing utility lines and yard piping where proposed work crosses at a lower elevation.
 - 1) Stabilize excavation to prevent undermining of existing utility and yard piping.
 - 2. Open trench outside buildings, units, and structures:
 - a. No more than the distance between two manholes, structures, units, or 300 LF, whichever is less.
 - b. Field adjust limitations as weather conditions dictate.
 - 3. Trenching within buildings, units, or structures:
 - a. No more than 100 LF at any one time.
 - 4. Any trench or portion of trench, which is opened and remains idle for seven calendar days, or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to Owner.
 - a. Said trench may not be reopened until Owner is satisfied that work associated with trench will be prosecuted with dispatch.
 - 5. Observe following trenching criteria:
 - a. Trench size:
 - 1) Excavate width to accommodate free working space.
 - 2) Maximum trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than the following dimensions:

OVERALL DIAMETER OF UTILITY SERVICE	EXCESS DIMENSION
33 IN and less	18 IN
more than 33 IN	24 IN

- 3) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
- 4) Keep trenches free of surface water runoff.
 - a) Include cost in Bid.
 - b) No separate payment for surface water runoff pumping will be made.

E. Trenching for Electrical Installations:

1. Observe the preceding Trench Excavation paragraph in PART 3 of this Specification Section.
2. Modify for electrical installations as follows:
 - a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
 - b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
 - c. Do not over excavate trench.
 - d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
 - e. See Division 26 for additional requirements.

F. Flowable Fill:

1. Flowable fill shall be:
 - a. Discharged from a mixer by any means acceptable to the Engineer into the area to be filled.
 - b. Placed in 4 FT maximum lifts to the elevations indicated.
 - 1) Allow 12 HR set-up time before placing next lift or as approved by the Engineer.
 - 2) Place flowable fill lifts in such a manner as to prevent flotation of the pipe.
2. Flowable fill shall not be placed on frozen ground.
3. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
4. Conform to appropriate requirements of Specification Section 31 23 00.
5. Flowable fill batching, mixing, and placing may be started if weather conditions are favorable, and the air temperature is 34 DEGF and rising.
6. At the time of placement, flowable fill must have a temperature of at least 40 DEGF.
7. Mixing and placing shall stop when the air temperature is 38 DEGF or less and falling.
8. Each filling stage shall be as continuous an operation as is practicable.
9. Prevent traffic contact with flowable fill for at least 24 HRS after placement or until flowable fill is hard enough to prevent rutting by construction equipment.
10. Flowable fill shall not be placed until water has been controlled or groundwater level has been lowered in conformance with the requirements of the preceding Groundwater Dewatering paragraph in PART 3 of this Specification Section.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Over-Excavation:

1. Backfill and compact to 90 PCT of maximum dry density per ASTM D698.
2. Backfill with granular bedding material as option.

B. Rock Excavation:

1. Excavate minimum of 6 IN below bottom exterior surface of the pipe or conduit.
2. Backfill to grade with suitable earth or granular material.
3. Form bell holes in trench bottom.

- C. Subgrade Stabilization:
 - 1. Stabilize the subgrade when directed by the Owner.
 - 2. Observe the following requirements when unstable trench bottom materials are encountered.
 - a. Notify Owner when unstable materials are encountered.
 - 1) Define by drawing station locations and limits.
 - b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.
 - 1) Replace with subgrade stabilization with no additional compensation.

3.4 BACKFILLING METHODS

- A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.
- B. Carefully Compacted Backfill:
 - 1. Furnish where indicated on Drawings, specified for trench embedment conditions and for compacted backfill conditions up to 12 IN above top of pipe or conduit.
 - 2. Comply with the following:
 - a. Place backfill in lifts not exceeding 8 IN (loose thickness).
 - b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
 - c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - d. Compact each lift to specified requirements.
- C. Common Trench Backfill:
 - 1. Perform in accordance with the following:
 - a. Place backfill in lift thicknesses capable of being compacted to densities specified.
 - b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
- D. Water flushing for consolidation is not permitted.
- E. Backfilling for Electrical Installations:
 - 1. Observe the preceding Carefully Compacted Backfill paragraph or Common Trench Backfill paragraph in PART 3 of this Specification Section or when approved by the Engineer.
 - 2. Modify for electrical installation as follows:
 - a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

3.5 COMPACTION

- A. General:
 - 1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
 - 2. In no case shall degree of compaction below minimum compactions specified be accepted.
- B. Compaction Requirements:
 - 1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
 - a. Bedding material:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

- b. Carefully compacted backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All applicable areas	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

c. Toe drain bedding and backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	60 PCT relative density by ASTM D4253 and ASTM D4254

d. Common trench backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
Under pavements, roadways, surfaces within highway right-of-ways	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	60 PCT of relative density by ASTM D4253 and ASTM D4254
Under turf, sodded, plant seeded, nontraffic areas	Cohesive soils	85 PCT of maximum dry density by ASTM D698
	Cohesionless soils	40 PCT of relative density by ASTM D4253 and ASTM D4254

3.6 FIELD QUALITY CONTROL

A. Testing:

1. Perform in-place moisture-density tests as directed by the Owner.
2. Perform tests through recognized testing laboratory approved by Owner.
3. Costs of "Passing" tests paid by Owner.
4. Perform additional tests as directed until compaction meets or exceeds requirements.
5. Cost associated with "Failing" tests shall be paid by Contractor.
6. Reference to Engineer in this Specification Section will imply Geotechnical Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.
7. Assure Owner has immediate access for testing of all soils related work.
8. Ensure excavations are safe for testing personnel.

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Diversion Channels.
 - 2. Rock Energy Dissipator.
 - 3. Paved Energy Dissipator.
 - 4. Rock Basin.
 - 5. Rock Barriers.
 - 6. Sediment Ponds.
 - 7. Sediment Traps.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T88, Standard Specification for Particle Size Analysis of Soils.
 - b. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 KG (10 LB) Rammer and a 457 MM (18 IN) Drop.
 - 2. American Concrete Institute (ACI):
 - a. 301, Specifications for Structural Concrete.
 - 3. ASTM International (ASTM):
 - a. C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - b. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³ (600 kN-M/M<sup>3 - c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT³ (2,700 kN-M/M<sup>3 - d. D2922, Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - e. D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).</sup></sup>
 - 4. Precast/Prestressed Concrete Institute (PCI):
 - a. MNL-116S, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data:
 - 1. Submit data on curing compounds geotextile.
 - 2. Submit proposed mix design of each class of concrete for review prior to commencement of Work.
- C. Project Information:
 - 1. Certified tests results for precast concrete at manufacturing facility, cast-in-place concrete in field, and granular backfill.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Do not place grout when air temperature is below freezing.
- B. Do not place concrete when base surface temperature is less than DEGF 40, or surface is wet or frozen.

PART 2 - PRODUCTS

- A. Geotextile Fabric: As specified in Section 31 37 00

2.2 SOURCE QUALITY CONTROL (AND TESTS)

- A. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.
- B. Test samples in accordance with ACI 301.
- C. Make rock available for inspection at producer's prior to shipment. Notify Architect/Engineer Owner at least seven days before inspection is allowed.
- D. Allow witnessing of inspections and test at manufacturer's test facility. Notify Architect/Engineer Owner at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support devices and imposed loads.
- B. Verify gradients and elevations of base or foundation for other work are correct.

3.2 FIELD QUALITY CONTROL

- A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.
- B. Field test concrete in accordance with Section 03 33 00.
- C. Compaction Testing: As specified in Section 31 23 23.
- D. Compaction Testing: In accordance with ASTM D1557.
- E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- F. Frequency of Compaction Testing: One for each lift.

3.3 CLEANING

- A. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.
- B. Do not damage structure or device during cleaning operations.
- C. Do not permit sediment to erode into construction or site areas or natural waterways.
- D. Clean channels when depth of sediment reaches approximately one half channel depth.

3.4 PROTECTION

- A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

- B. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION

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SECTION 31 32 19

GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonwoven geotextile material.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway Transportation Officials (AASHTO):
 - a. M288, Standard Specification for Geotextile Specification for Highway Applications.
 - 2. ASTM International (ASTM):
 - a. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
 - c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - f. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - g. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
 - h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
 - i. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
- B. Qualifications:
 - 1. Each manufacturing, fabricating firm shall demonstrate five years continuous experience, including a minimum of 10,000,000 SQFT of geotextile installation in the past three years.
 - 2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 SQFT of geotextile.
 - 3. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

- A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
 - 3. Manufacturer and Installer quality control manuals.

4. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
 - a. Results shall include or bracket the rolls delivered for use in the Work.
 5. Geotextile layout plan with proposed size, number, position and sequencing of geotextile rolls and direction of all field seams.
 6. Proposed details of anchoring and overlapping if different than included in Contract Documents.
- B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. For needle punched geotextiles, the manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
 3. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. See Specification Section 01 65 50.
- B. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.
- C. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
 1. Do not remove the plastic wrapping until deployment.
- D. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).
- E. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.
- F. Do not expose geotextile to temperatures in excess of 71 DEGC (160 DEGF) or less than 0 DEGC (32 DEGF) unless recommended by the manufacturer.
- G. Do not use hooks, tongs or other sharp instruments for handling geotextile.
 1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
 2. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. GSE Lining Technology.
 2. Propex Geosynthetics.
 3. SKAPS Industries.
 4. TenCate Mirafi.
 5. Tenax.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS AND MANUFACTURE

- A. Geotextile:
 1. Nonwoven pervious sheet of polymeric material.
 2. Geotextile fibers:
 - a. Long-chain synthetic polymer composed of at least 85 PCT by weight polyolefins, polyesters, or polyamides.
 - b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
 - c. Do not as reclaimed or recycled fibers or polymer to the formulation.

3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
 - a. Values shown are for the weaker principal direction.
 - b. Acceptance of geotextile shall be in accordance with ASTM D4759.
 - c. Type I Geotextile: AASHTO M288 Class 2, for use in demolition fill.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=10
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 HRS	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

- d. Type 2 Geotextile: AASHTO M288 Class 2, for use in drainage composite and other areas shown on the Drawings.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=8
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 HRS	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

B. Thread:

1. High-strength polyester, nylon, or other approved thread type.
2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
3. Contrasting color with the geotextile.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

- A. Install geotextiles in accordance with manufacturer's written recommendations.
- B. Hand place geotextile.
 - 1. No equipment will be permitted to traffic in direct contact with the geotextile.
- C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.
- D. Seam Construction:
 - 1. Sew all Type I geotextile seams.
 - 2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
 - 3. Sew seams continuously using an SSA flat seam with one row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
 - 4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 IN unless otherwise recommended by the manufacturer.
 - 5. Test seams at the frequency specified in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
 - 6. Tie off thread at the end of each seam to prevent unraveling.
 - 7. Construct seams on the top side of the geotextile to allow inspection.
 - 8. Sew skipped stitches or discontinuities with an extra line of stitching with 18 IN of overlap.
 - 9. Type 2 geotextile seams may be sewn or overlapped.
 - a. Construct overlapped seams in accordance with manufacturer's recommendations or as shown on Drawings.
- E. Heat tack the geotextile overlaps as shown on the Drawings.
- F. Backfill anchor trenches in accordance with Specification Section 31 23 00.
- G. Place cover soil in accordance with Specification Section 31 23 00.
- H. Protect geotextiles from clogging, tears, and other damage during installation.
- I. Geotextile Repair:
 - 1. Place a patch of the same type of geotextile which extends a minimum of 12 IN beyond the edge of the damage or defect.
 - 2. Fasten patches continuously using a sewn seam or other approved method.
 - 3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
 - 4. Replace geotextile which cannot be repaired.
- J. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.
- K. Do not use staples or pins to hold the geotextile in place.
- L. Do not leave geotextile uncovered for more than 14 days.

3.3 FIELD QUALITY CONTROL

- A. Conduct destructive seam testing at locations identified by Owner.
 - 1. Minimum testing will be at a frequency of one test per 2,000 linear feet of seam.
- B. Provide as-constructed drawing showing roll number; layout; joint locations; and destructive sample repair, and patch locations.

END OF SECTION



DIVISION 32

EXTERIOR IMPROVEMENTS



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SECTION 32 31 13
CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Chain link fencing and gates.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - c. A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain-Link Fence.
 - d. F552, Standard Terminology Relating to Chain Link Fencing.
 - e. F567, Standard Practice for Installation of Chain-Link Fence.
 - f. F626, Standard Specification for Fence Fittings.
 - g. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
 - h. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
 - i. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
 - 2. American Welding Society (AWS).
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 70, National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL).
- B. Qualifications:
 - 1. Installer bonded and licensed in the Project state.
 - 2. Installer shall have a minimum two years' experience installing similar fencing.
 - 3. Utilize only AWS certified welders.
 - 4. Electric gate operators to be UL listed.
 - 5. Grounding by an electrician licensed in Project state.

1.3 DEFINITIONS

- A. See ASTM F552.
- B. NPS: Nominal pipe size, in inches.
- C. Installer or Applicator:
 - 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 - 2. Installer and applicator are synonymous.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
 - 4. Mill certificates.
 - 5. Source quality control test results.
 - 6. Automatic gate system:
 - a. Electrical circuitry and control wiring.
 - b. Intercom system.
 - c. Detector loop layout.
 - d. Locking plan.
 - e. Method of installation of detector loop.
 - f. Sealant material for detector loops.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Chain Link Fabric:
 - 1. Fabric type:
 - a. ASTM A392 zinc-coated steel:
 - 1) Coated before weaving, 2.0 OZ/SQFT.
 - 2. Wire gage: .
 - 3. Mesh size: IN.
 - 4. Selvage treatment:
 - a. Top: Twisted and barbed.
 - b. Bottom:.
- B. Concrete: See Specification Section 03 00 00 - Concrete.
- C. Line Post:
 - 1. ASTM F1083 pipe:
 - a. Schedule 40, NPS 2.
- D. Corner or Terminal Posts:
 - 1. ASTM F1083 pipe:
 - a. Schedule 40, NPS 2-1/2.
- E. Brace and Rails:
 - 1. ASTM F1083 pipe:
 - a. Schedule 40, NPS 1-1/4.
- F. Tension Wire:
 - 1. Top and bottom of fabric:
 - a. ASTM A824, galvanized steel, Class 3.
- G. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):
 - 1. ASTM F626.
- H. Swing Gate:
 - 1. ASTM F900.
 - 2. Materials as specified for fence framework and fabric.

3. Hardware:
 - a. Galvanized per ASTM A153/A153M.
 - b. Hinges to permit 90 DEG in and out gate opening.

2.2 SOURCE QUALITY CONTROL

- A. Test related fence construction materials to meet the following standards:
 1. Posts and rails: ASTM F1043, Heavy Industrial.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with:
 1. Manufacturer's instructions.
 2. Lines and grades shown on Drawings.
 3. ASTM F567.
- B. Do not start fence installation before final grading is complete and finish elevations are established.
- C. Drill holes in firm, undisturbed or compacted soil.
- D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.
 1. Correct minor irregularities in earth to maintain maximum clearance.
- E. Space line posts at equal intervals not exceeding 10 FT OC.
- F. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.
- G. Install tension bars full height of fabric.
- H. Rails:
 1. Fit rails with expansion couplings of outside sleeve type.
 2. Rails continuous for outside sleeve type for full length of fence.
- I. Provide expansion couplings in top rails at not more than 20 FT intervals.
- J. Anchor top rails to main posts with appropriate wrought or malleable fittings.
- K. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.
 1. Locate compression members at mid-height of fabric.
 2. Extend diagonal tension members from compression members to bases of posts.
 3. Install so that posts are plumb when under correct tension.
- L. Pull fabric taut and secure to posts and rails.
 1. Secure so that fabric remains in tension after pulling force is released.
 2. Secure to posts at not over 15 IN OC, and to rails at not over 24 IN OC, and to tension wire at not over 24 IN OC.
 3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
 4. Bend ends of wire to minimize hazards to persons or clothing.
- M. Install post top at each post.
- N. Gates:
 1. Construct with fittings or by welding.
 2. Provide rigid, weatherproof joints.
 3. Assure right, non-sagging, non-twisting gate.
 4. Coat welds with rust preventive paint, color to match pipe.
- O. Install electric gate operator in accordance with NFPA 70.

END OF SECTION



DIVISION 33

UTILITIES



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SECTION 33 05 16
PRECAST CONCRETE MANHOLE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Precast concrete round manhole structures and appurtenant items.
 - a. Sanitary sewer manholes and appurtenances.
 - b. Drain manholes and appurtenances.
 - c. Storm sewer manholes and appurtenances.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 21 00 - Reinforcement.
 - 4. Section 03 31 30 - Concrete Materials and Proportioning.
 - 5. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A48/A48M, Standard Specification for Gray Iron Castings.
 - b. C150/C150M, Standard Specification for Portland Cement.
 - c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - d. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - e. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
 - f. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Fabrication and/or layout drawings:
 - a. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
 - b. Itemize, on separate schedule, sectional breakdown of each manhole structure with all components and refer to drawing identification number or notation.
 - c. Indicate knockout elevations for all piping entering each manhole.
 - 4. Buoyancy uplift and structural calculations.
 - 5. Drawings shall be signed and sealed by a Professional Engineer registered in state corresponding to the project location.
- B. Unless approved prior to submittal, submit all products from this Specification Section in one complete submittal package. Include all products and accessories together.

1.4 SITE CONDITIONS

- A. For the Lower Site, the established high groundwater elevation is 70 FT MSL (Mean Sea Level).
- B. For the Upper Site, the established high groundwater elevation is 83 FT MSL.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Manhole rings, covers and frames:
 - a. Neenah Foundry and Neenah Enterprises, Inc.
 - b. Deeter Foundry.
 - 2. Black mastic joint compound:
 - a. Kalktite 340.
 - b. Tufflex.
 - c. Plastico.
 - 3. Premolded joint compound:
 - a. RAM-NEK.
 - b. Kent Seal.
 - 4. Emulsified fibrated asphalt compound:
 - a. Sonneborn Hydrocide 700B.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 SANITARY SEWER, STORM AND DRAIN MANHOLE STRUCTURE COMPONENTS

- A. Manhole Components:
 - 1. Reinforcement: ASTM C478.
 - 2. Minimum wall thickness: 5 IN.
 - 3. Minimum base thickness: 12 IN.
 - 4. Provide the following components for each manhole structure:
 - a. Base (precast) with integral bottom section or (cast-in-place).
 - b. Precast bottom section(s).
 - c. Precast barrel section(s).
 - d. Precast eccentric transition section.
 - e. Precast adjuster ring(s).
 - f. Precast concrete transition section.
 - g. Precast flat top.
 - 5. Unless dimensioned or specifically noted on Drawings, provide manhole section with minimum 48 IN inside dimensions.
- B. Nonpressure Type Frames and Cover:
 - 1. Cast iron frame and covers: ASTM A48/A48M, Class 35 (minimum).
 - 2. Use only cast or ductile iron of best quality, free from imperfections and blow holes.
 - 3. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 LBS.
 - 4. Machine all horizontal surfaces.
 - 5. Furnish unit with solid nonventilated lid with concealed pickholes.
 - a. Letter covers "SEWER" for all collection system manholes, "DRAIN" for all gravity unit drains returning flow to the headworks, and "STORM" for storm sewer systems.
 - 6. Ensure minimum clear opening of 24 IN DIA.
- C. Pressure Type Frame and Cover:
 - 1. Provide covers meeting the requirements of the Nonpressure Type Frames and Cover paragraph above and as modified below.
 - 2. Furnish frame and bolted cover of heavy-duty construction.
 - a. Equip unit with six stainless steel countersunk 3/8 IN DIA by 1-1/2 IN long bolts with stainless steel washers.
 - 3. Provide solid lid and minimum 1/8 IN thick x 1/2 IN wide continuous strip neoprene gasket.

4. Furnish unit with a minimum of six anchorage holes and six, 6 IN long x 3/4 IN DIA stainless steel anchor bolts.
- D. Special Coatings and Joint Treatment:
1. Joints of precast sections:
 - a. Black mastic compound: ASTM D4586.
 2. Vertical wall surfaces:
 - a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type II for all exterior vertical wall surfaces.
- E. Sanitary Sewer Manhole Concrete:
1. Provide all sanitary manholes constructed with Portland ASTM C150/C150M, Type I or II cement with a tricalcium aluminate content not to exceed 8 PCT.
 2. Mix aggregate shall be a minimum of 50 PCT crushed limestone.
 3. Provide 3000 PSI nonshrink grout.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

- A. General:
1. Construct cast-in-place concrete base slabs.
 2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
 3. On all straight runs, lay pipe through manhole and cut out top half of pipe.
 - a. See detail on Drawings.
 - b. If pipes deflect at manhole, shape as specified in Paragraphs 2 and 4 IN this General Paragraph.
 4. Shape inverts accurately and steel trowel finish.
 - a. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert using as large a radius as manhole inside diameter will permit.
 - b. Pour base slab integral with bottom barrel section.
- B. Build each manhole to dimensions shown on plans and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.
- C. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 IN immediately prior to mating the surfaces.
- D. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.
- E. Seal all pipe penetrations in manhole.
1. Form pipe openings smooth and well-shaped.
 2. After installation, seal cracks with, non-shrink grout.
 3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.
- F. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

END OF SECTION

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SECTION 33 05 23
PIPELINE UNDERCROSSINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Construction of pipe undercrossings.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Compliance with submittal requirements of authority or agency having jurisdiction over undercrossing.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Casing Pipe:
 - 1. Structural grade steel: Minimum yield strength of 35,000 PSI or greater as required by the permits.
 - 2. Wall thickness: Minimum 0.250 IN or greater as required by the permits.
 - 3. Diameter: Minimum of 4 IN larger than outside diameter of carrier pipe's jointing system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install undercrossing to meet requirements of authority or agency having jurisdiction over undercrossing.
 - 2. Observe work requirements stipulated in any permit condition.
 - 3. Consult Contract Drawings for limitation of construction right-of-way.
- B. If installation of crossing is by jacking or dry boring, the following will be required unless more rigid requirements are specified by the authority or agency having jurisdiction over the crossing:
 - 1. Diameter of the hole: Not exceeding diameter of casing by more than 1-1/2 IN.
 - 2. Pressure grout all voids outside of casing, including abandoned or misaligned holes.
 - 3. Fill void between carrier pipe and casing wall with blow sand.
 - a. Install watertight grouted plug minimum of 1 FT deep at both ends.

4. Undercrossing casing:
 - a. Full lengths.
 - b. Weld pressure tight.
5. After casing is installed, band wood blocks 120 DEG apart to each length of carrier pipe to prevent displacement and pull pipe into place.
 - a. Pipe must be straight and centered in casing when in place.
6. Coordinate connections to system with authority or agency having jurisdiction over the crossing.

END OF SECTION



DIVISION 40

PROCESS INTERCONNECTIONS



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SECTION 40 05 00
PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Process piping systems.
 - 2. Utility piping systems.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.
 - 4. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
 - 5. Section 40 05 07 - Pipe Support Systems.
 - 6. Section 40 05 51 - Valves - Basic Requirements.
 - 7. Section 40 41 13 - Heat Tracing Cable.
 - 8. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M278, Standard Specification for Class PS 46 Polyvinyl Chloride (PVC) Pipe.
 - 2. American Iron and Steel Institute (AISI).
 - 3. American Society of Mechanical Engineers (ASME):
 - a. B16.3, Malleable Iron Threaded Fittings.
 - b. B16.5, Pipe Flanges and Flanged Fittings.
 - c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
 - d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
 - e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - f. B36.19, Stainless Steel Pipe.
 - g. B40.100, Pressure Gauges and Gauge Attachments.
 - 4. ASTM International (ASTM):
 - a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
 - c. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - e. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - f. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - g. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - h. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - i. A536, Standard Specification for Ductile Iron Castings.
 - j. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
 - k. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

- l. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- m. B88, Standard Specification for Seamless Copper Water Tube.
- n. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- o. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- p. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- q. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- r. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
- 5. American Water Works Association (AWWA):
 - a. B300, Standard for Hypochlorites.
 - b. C200, Standard for Steel Water Pipe - 6 IN and Larger.
 - c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
 - d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
 - e. C606, Standard for Grooved and Shouldered Joints.
 - f. C651, Standard for Disinfecting Water Mains.
 - g. C800, Standard for Underground Service Line Valves and Fittings.
- 6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
 - b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.
- 7. Cast Iron Soil Pipe Institute (CISPI):
 - a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.3 DEFINITIONS

- A. HPIC: High performance industrial coating.

1.4 SYSTEM DESCRIPTION

- A. Piping Systems Organization and Definition:
 - 1. Piping services are grouped into designated systems according to the chemical and physical properties of the fluid conveyed, system pressure, piping size and system materials of construction.
 - 2. For Process Piping see Process Pipe Schedule and Process Piping material Schedule in Drawings..
 - 3. For Domestic Plumbing and HVAC see Divisions 22 & 23.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.

- c. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
 - 1) Attach technical product data on gaskets, pipe, fittings, and other components.
 - 3. Fabrication and/or Layout Drawings:
 - a. Exterior yard piping drawings (minimum scale 1 IN equals 10 FT) with information including:
 - 1) Dimensions of piping lengths.
 - 2) Invert or centerline elevations of piping crossings.
 - 3) Acknowledgement of bury depth requirements.
 - 4) Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.
 - 5) Acknowledge designated valve or gate tag numbers, manhole numbers, instrument tag numbers, pipe and line numbers.
 - 6) Line slopes and vents.
 - b. Interior piping drawings (minimum scale 1/8 IN equals 1 FT) with information including:
 - 1) Dimensions of piping from column lines or wall surfaces.
 - 2) Invert or Centerline dimensions of piping.
 - 3) Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.
 - 4) Location and type of pipe supports and anchors.
 - 5) Locations of valves and valve actuator type.
 - 6) Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
 - 7) Acknowledgement of valve, equipment and instrument tag numbers.
 - 8) Provisions for expansion and contraction.
 - 9) Line slopes and air release vents.
 - 10) Rough-in data for plumbing fixtures.
 - c. Schedule of interconnections to existing piping and method of connection.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. Qualifications of lab performing disinfection analysis on water systems.
 - 2. Test reports:
 - a. Copies of pressure test results on all piping systems.
 - b. Reports defining results of dielectric testing and corrective action taken.
 - c. Disinfection test report.
 - d. Notification of time and date of piping pressure tests.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe coating during handling using methods recommended by manufacturer.
 - 1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.
- B. Prevent damage to pipe during transit.
 - 1. Repair abrasions, scars, and blemishes.
 - 2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Insulating unions:
 - a. "Dielectric" by Epco.
2. Chemical strainers (Y type):
 - a. Chemtrol.
 - b. Asahi.
3. Camlock fittings:
 - a. PT Coupling
4. Dielectric flange kit:
 - a. PSI.
 - b. Maloney.
 - c. Central Plastics.
5. Pipe saddles (for gage installation):
 - a. Dresser Style 91 (steel and ductile iron systems).
 - b. Dresser Style 194 (nonmetallic systems).
6. Expansion joint at FRP and poly tanks:
 - a. PROCO.
 - b. Garlock, Style 215.
7. Metal bellows type expansion joints:
 - a. Metraflex, MNLC
 - b. Triad, equivalent model.
 - c. Or equal.
8. Elastomeric bellows type expansion joints:
 - a. Garlock, Guardian 200/204.
 - b. PROCO, equivalent model.
 - c. Red Valve, equivalent model.
 - d. Or equal.
9. Dismantling Joint
 - a. Romac DJ400.
 - b. Smith Blair 972.
10. Tapping Sleeve
 - a. Romac FTS419

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 COMPONENTS AND ACCESSORIES

A. Insulating Components:

1. Dielectric flange kits:
 - a. Flat faced.
 - b. 1/8 IN thick dielectric gasket, phenolic, non-asbestos.
 - c. Suitable for 175 PSI, 210 DEGF.
 - d. 1/32 IN wall thickness bolt sleeves.
 - e. 1/8 IN thick phenolic insulating washers.
2. Dielectric unions:
 - a. Screwed end connections.
 - b. Rated at 175 PSI, 210 DEGF.
 - c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

B. Dirt Strainers:

1. Y-type.
2. Composition bronze.

3. Rated for test pressure and temperature of system in which they are installed.
 4. 20 mesh Monel screen.
 5. Threaded bronze plug in the blowoff outlet.
 6. Threaded NPT end connections.
- C. Strainers for Chemical Applications:
1. Y-type.
 2. Strainers of same material, test pressure, and temperature rating as system in which strainer is placed.
- D. Reducers:
1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
 2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.
- E. Protective Coating and Lining:
1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.
 2. Field coating pipe in accordance with Specification Section 09 96 00.
- F. Underground Warning Tape:
1. See Specification Section 10 14 00.
- G. Pressure Gages:
1. See Specification Section 01 61 03 and Specification Section 40 91 10.
- H. Expansion Joints at FRP and Poly Tanks:
1. Materials:
 - a. Bellows: PTFE-62.
 - b. Flanges: PVC, ductile iron.
 - c. Limit bolts and nuts: Epoxy coated carbon steel.
 - d. Reinforcing rings: Stainless steel.
 2. Pressure rating at 70 DEGF: 70 PSIG.
 3. Minimum axial movement: 3/8 IN.
- I. Elastomeric Bellows Type Expansion Joints:
1. Provide reducing type where indicated on the Drawings.
 2. Flanges: ANSI 125/150.
 3. Materials:
 - a. Bellows:
 - 1) Sludge service: Natural rubber.
 - 2) All other: Compatible with fluid.
 - b. Restraint:
 - 1) Provide restraint limit bolts (control rods) and nuts to restrain joint at test pressure of piping.
 - 2) Control rod material: 316 stainless steel.
 - c. Working pressure: Equal to or greater than test pressure of connecting piping.
 - d. Minimum axial movement: 3/8 IN.
 4. Arches:
 - a. Sludge service: Provide single filled arches.
 - b. All other service: Provide double open arches.
- J. Tapping Sleeve
1. Carbon steel construction 150 psi rated, factory fusion epoxy coating and lining.
 2. High strength, low alloy, steel bolts per AWWA C111
 3. Flanged branch.

PART 3 - EXECUTION

3.1 EXTERIOR BURIED PIPING INSTALLATION

- A. Unless otherwise shown on the Drawings, provide a minimum of 4 FT and maximum of 8 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.
- B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.
- C. When entering or leaving structures or passing beneath the vertical projection of a structure wall use flexible joint piping with first joint installed within 2 FT of point where pipe enters or leaves structure.
 - 1. Install second joint not more than 6 FT nor less than 4 FT from first joint.
- D. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
- E. Install expansion devices as necessary to allow expansion and contraction movement.
- F. Laying Pipe In Trench:
 - 1. Excavate and backfill trench in accordance with Specification Section 31 23 33.
 - 2. Clean each pipe length thoroughly and inspect for compliance to specifications.
 - 3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
 - 4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
 - 5. Except for first two joints, before making final connections of joints, install two full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
 - 6. Lay pipe in only suitable weather with good trench conditions.
 - a. Never lay pipe in water except where approved by Engineer.
 - 7. Seal open end of line with watertight plug if pipe laying stopped.
 - 8. Remove water in trench before removal of plug.
- G. Lining Up Push-On Joint Piping:
 - 1. Lay piping on route lines shown on Drawings.
 - 2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
 - 3. Observe maximum deflection values stated in manufacturer's written literature.
 - 4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
 - 5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.
- H. Anchorage and Blocking:
 - 1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
 - 2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
 - a. Concrete blocks shall not cover pipe joints.
 - 3. Provide bearing area of concrete in accordance with drawing detail.
- I. Install underground hazard warning tape per Specification Section 10 14 00.
- J. Install insulating components where dissimilar metals are joined together.

3.2 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

- A. Install piping in vertical and horizontal alignment as shown on Drawings.
- B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
 - 1. Expansion and contraction.

2. Operation and access to equipment, doors, windows, hoists, moving equipment.
 3. Headroom and walking space for working areas and aisles.
 4. System drainage and air removal.
- C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.
- D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.
- E. Pipe Support:
1. Use methods of piping support as shown on Drawings and as required in Specification Section 40 05 07.
 2. Piping support systems for piping 12 IN and greater are shown on the Drawings.
 - a. Contractor is responsible for design of these support systems per Specification Section 40 05 07.
 3. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
 - a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
 4. Size pipe supports with consideration to specific gravity of liquid being piped.
- F. Locate and size sleeves and castings required for piping system.
1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.
- G. Use reducing fittings throughout piping systems.
1. Bushings will not be allowed unless specifically approved.
- H. Equipment Drainage and Miscellaneous Piping:
1. Provide drip pans and piping at equipment where condensation may occur.
 2. Hard pipe stuffing box leakage to nearest floor drain.
 3. Avoid piping over electrical components such as motor control centers, panelboards, etc.
 - a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
 - b. Hard pipe drainage to nearest floor drain.
 4. Collect system condensate at drip pockets, traps and blowoff valves.
 5. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.
 6. For applications defined above and for other miscellaneous piping which is not addressed by a specific piping service category in PART 1, provide 304 stainless steel piping and fittings.
 - a. Size to handle application with 3/4 IN being minimum size provided.
- I. Unions:
1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
 2. Mechanical type couplings may serve as unions.
 3. Additional flange unions are not required at flanged connections.
- J. Install expansion devices as necessary to allow expansion/contraction movement.
- K. Provide full face gaskets on all systems.
- L. Anchorage and Blocking:
1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.
- M. Equipment Pipe Connections:
1. Equipment - General:

- a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
 - b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
 - c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
 - 1) Provide tightening torque in accordance with manufacturer's recommendations.
 - d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
 - e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
 - f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
 - g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
 - h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
 - 1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
 - 2) Realign as necessary, install flange bolts and make equipment connection.
 - i. Provide utility connections to equipment shown on Drawings, scheduled or specified.
- N. Provide insulating components where dissimilar metals are joined together.
- O. Instrument Connections:
- 1. See drawing details.

3.3 CONNECTIONS WITH EXISTING PIPING

- A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.
- B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.
- C. Undertake connections in fashion which will disturb system as little as possible.
- D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.
- E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.
- F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.
- G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.4 ACCESS PROVISIONS

- A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.
- B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.
- C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.
- D. Provide with key locks, keyed alike, in public use areas.
- E. Furnish panels with prime coat of HPIC. See Specification Section 09 96 00.

- F. Style and type as required for material in which door installed.
- G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.5 CATHODIC PROTECTION

- A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.
- B. Make all connections from wire or cable by Thermit Cadwelding accomplished by operators experienced in this process.
- C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 PCT of the straight line length.
- D. After cadwelding, coat all exposed metallic surfaces with hot applied tape.

3.6 HEAT TRACING

- A. See Specification Section 40 41 13 - Heat Tracing Cable.

3.7 PRESSURE GAGES

- A. Provide at locations shown on the Drawings and specified.
- B. See Specification Section 01 61 03.

3.8 FIELD QUALITY CONTROL

- A. Pipe Testing - General:
 - 1. Test piping systems as follows:
 - a. Test exposed, non-insulated piping systems upon completion of system.
 - b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
 - c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
 - d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
 - 2. For Process Piping utilize pressures and media as indicated in the Process Pipe Schedule in the Drawings. Duration of tests shall be four hours unless noted otherwise.
 - 3. Isolate equipment which may be damaged by the specified pressure test conditions.
 - 4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
 - a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
 - b. Notify the Engineer 24 HRS prior to each test.
 - 5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
 - 6. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
 - 7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
- B. Pressure Testing:
 - 1. Testing medium: Unless otherwise specified in the Process Pipe Schedule in the Drawings, utilize the following test media.
 - a. Process systems:

PIPE LINE SIZE	SPECIFIED TEST PRESSURE	TESTING MEDIUM
2 IN and smaller	75 PSI or less	Water

PIPE LINE SIZE	SPECIFIED TEST PRESSURE	TESTING MEDIUM
2 IN and smaller	Greater than 75 PSI	Water
Greater than 2 IN	3 PSI or less	Water
Greater than 2 IN	Greater than 3 PSI	Water

b. Liquid systems:

PIPE LINE SIZE (DIA)	GRAVITY OR PUMPED	SPECIFIED TEST PRESSURE	TESTING MEDIUM
Up to and including 48 IN	Gravity	25 PSIG or less	Water
Above 48 IN	Gravity	25 PSIG or less	Water
All sizes	Pumped	250 PSIG or less	Water

2. Allowable leakage rates:

- a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage goal at the specified test pressure throughout the duration of the test.
- b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
 - 1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
 - 2) Average head is defined from groundwater elevation to average pipe crown.
 - 3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) equals 115 by (actual test head to the 1/2 power).
- c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
 - 1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
 - 2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 by (actual head to the 1/2 power).
- d. Large diameter (above 48 IN) gravity plant piping systems shall have a maximum exfiltration of 25 GPD per inch-mile.
- e. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 PCT of the specified test pressure throughout the duration of the test.
- f. For low pressure (less than 25 PSIG) air testing, the acceptable time for loss of 1 PSIG of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3
48	7.6

3. Hydrostatic pressure testing methodology:
 - a. General:
 - 1) All joints, including welds, are to be left exposed for examination during the test.
 - 2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
 - 3) Provide temporary restraints for expansion joints for additional pressure load under test.
 - 4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
 - 5) Do not coat or insulate exposed piping until successful performance of pressure test.
 - b. Soil, waste, drain and vent systems:
 - 1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
 - 2) Eliminate leaks before proceeding with work or concealing piping.
 - 3) Minimum test heights shall be 10 FT above highest stack inlet.
 - c. Larger diameter (above 36 IN) gravity plant piping:
 - 1) Plug downstream end of segment to be tested.
 - a) Provide bracing as required.
 - 2) Fill segment and upstream structure to normal operating level as per hydraulic profile.
 - 3) Allow 24 HRS for absorption losses.
 - a) Refill to original level.
 - 4) Provide reservoir to maintain constant head over duration of test.
 - 5) Record reservoir water volume at beginning and end of test.
4. Air testing methodology:
 - a. General:
 - 1) Assure air is ambient temperature.
 - b. Low pressure air testing:
 - 1) Place plugs in line and inflate to manufacturer's designated seal pressure.
 - 2) Check plugs for proper sealing.
 - 3) Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water or allowable limits of ASTM F1417.
 - a) Use test gage conforming to ASME B40.100 with 0 to 15 PSI scale and accuracy of 1 PCT of full range.
 - 4) Allow 2 minutes for air pressure to stabilize.
 - 5) After stabilization period (3.5 PSIG minimum pressure in pipe) discontinue air supply to line segment.
 - 6) Record pressure at beginning and end of test.
- C. Dielectric Testing Methods and Criteria:
 1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.

2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.9 CLEANING, DISINFECTION AND PURGING

- A. Cleaning:
 1. Clean interior of piping systems thoroughly before installing.
 2. Maintain pipe in clean condition during installation.
 3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
 - a. Pig high pressure air piping before connecting to valves or instruments.
 4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
 5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
 - a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
 - b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
- B. Disinfection of Potable Water Systems:
 1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
 2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
 3. Perform disinfection using sodium hypochlorite complying with AWWA B300.
 4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
 5. Drain flushing water to sanitary sewer.
 - a. Do not drain flushing water to receiving stream.
 6. Use continuous feed method of application.
 - a. Tag system during disinfection procedure to prevent use.
 7. After required contact period, flush system to remove traces of heavily chlorinated water.
 8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
 - a. Repeat entire disinfection procedures until satisfactory results are obtained.
 9. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
 - a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of ____Washington____.

3.10 LOCATION OF BURIED OBSTACLES

- A. Furnish exact location and description of buried utilities encountered and thrust block placement.
- B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.
- C. Include such information as location, elevation, coverage, supports and additional pertinent information.
- D. Incorporate information on "As-Recorded" Drawings.

3.11 PIPE INSULATION

- A. Insulate pipe and pipe fittings in accordance with Specification Section 40 42 00.

END OF SECTION

SECTION 40 05 07

PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe support and anchor systems.
 - 2. Design of Pipe Support Systems as specified.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 03 15 19 - Anchorage to Concrete.
 - 4. Section 05 50 00 - Metal Fabrications.
 - 5. Section 09 96 00 - High Performance Industrial Coatings.
 - 6. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B31.1, Power Piping.
 - b. B31.3, Process Piping.
 - 2. ANVIL International (ANVIL).
 - 3. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - d. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
 - e. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - f. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
 - g. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
 - h. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 4. American Welding Society (AWS):
 - a. D1.1, Structural Welding Code - Steel.
 - b. D1.6, Structural Welding Code - Stainless Steel.
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. SP-69, Pipe Hangers and Supports - Selection and Application.
- B. Responsibility:
 - 1. Support systems for piping greater than 12 IN DIA, or with internal pressure over 100 PSI, or piping with product temperatures over 200 DEGF, are shown on the Drawings and are not to be designed by Contractor unless indicated in Contract Documents.
 - 2. Design complete support systems for piping 12 IN and smaller where supports are not shown on the Drawings.
 - 3. Provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.

4. General piping support details may be indicated on the Drawings in certain locations for pipe 12 IN DIA and smaller.
 5. Incorporate those details with requirements of this Specification Section to provide the piping support system.
- C. Each type of pipe hanger or support shall be the product of one manufacturer.
- D. Qualifications:
1. Pipe support designer:
 - a. Licensed Professional Engineer registered in the state the project is located in.
 - b. Minimum of five years' experience designing pipe supports for projects of similar size and complexity.

1.3 SUBMITTALS

- A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
 - d. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
 - e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
 - f. Where Contract Documents indicate contractor is to design pipe support systems, submit detail design calculations and scaled drawings signed by Pipe support designer..

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

- A. General:
1. Galvanized components:
 - a. Electro-galvanized components:
 - 1) Bar, forged or cast fabrications: ASTM B633, SC4.
 - 2) Rolled sheet fabrications: ASTM A917 and ASTM A918, 50N50NU.
 - b. Hot-dipped galvanized components: See Specification Section 05 50 00.
 2. Dissimilar metals protection:
 - a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
 - b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.
- B. Hanger Rods:
1. Material:
 - a. ASTM A36.
 - b. ASTM A575, Grade M1020.
 - c. ASTM A576, Grade 1020.
 - d. Minimum allowable tensile stress of 12,000 PSI at 650 DEGF per MSS SP-58.
 2. Continuously threaded.
 3. Electro-galvanized or cadmium plated after threads are cut.

4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

C. Hangers:

1. Hangers for use directly on copper pipe: Copper or cadmium plated.
2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
3. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82
Service in chemical storage areas and as indicated on drawings for corrosion resistance	All	CorPro CP - Hanger or equal

D. Concrete Inserts for Hanger Rods:

1. Continuous slots: Unistrut #P1000.
2. Individual inserts: ANVIL Figure 281.
3. See Specification Section 03 15 19, mechanical anchors.

E. Beam Clamps for Hanger Rods:

1. Standard duty.
2. ANVIL Figure 133.

F. Trapeze Hangers for Suspended Piping:

1. General:
 - a. Material: Steel.
 - b. Galvanized.
 - c. Angles, channels, or other structural shapes.
 - d. Curved roller surfaces at support point corresponding with type of hanger required.
2. In chemical storage and feed areas and as indicated on the drawings:
 - a. Materials: FRP.
 - b. Unistrut fiberglass channel or equal.

G. Vertical Pipe Supports:

1. At base of riser.
2. Lateral movement:
 - a. Clamps or brackets:
 - 1) Stainless steel.
 - 2) ANVIL Figure 261.

H. Expanding Pipe Supports:

1. Spring hanger type.

2. MSS SP-58.
- I. Pipe Support Saddle:
 1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
 2. ANVIL Figure 264.
- J. Pipe Support Risers:
 1. Schedule 40 pipe.
 2. Galvanized.
 3. Size: As recommended by saddle manufacturer.
- K. Pipe Support Base Plate:
 1. 4 IN larger than support.
 2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
 3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
 4. Collar welded to floor plate.
 5. Edges ground smooth.
 6. Assembly hot-dipped galvanized after fabrication.
- L. Pipe Covering Protection Saddle:
 1. For insulated pipe at point of support.
 2. ANVIL Figure 167, Type B.
- M. Wall Brackets:
 1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
 2. ANVIL Figure 199.
- N. Pipe Anchors:
 1. For locations shown on the Drawings.
 2. 1/4 IN steel plate construction.
 3. Hot-dipped galvanized after fabrication.
 4. Designed to prevent movement of pipe at point of attachment.
- O. Pipe Guides:
 1. For locations on both sides on each expansion joint or loop.
 2. To ensure proper alignment of expanding or contracting pipe.
 3. ANVIL Figure 256.

2.3 DESIGN REQUIREMENTS

- A. Supports capable of supporting the pipe for all service and testing conditions.
 1. Provide 5 to 1 safety factor.
- B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- C. Design supports and hangers to allow for proper pitch of pipes.
- D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 1. ASME B31.3.
 2. MSS SP-58 and MSS SP-69.
 3. Except where modified by this Specification.
- E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 1. ASME B31.1.
 2. MSS SP-58 and MSS SP-69.
- F. Check all physical clearances between piping, support system and structure.

1. Provide for vertical adjustment after erection.
- G. Support vertical pipe runs in pipe chases at base of riser.
 1. Support pipes for lateral movement with clamps or brackets.
- H. Place hangers are to be installed on outside of pipe insulation.
 1. Use a pipe covering protection saddle for insulated pipe at support point.
 2. Insulated piping 1-1/2 IN and less:
 - a. Provide a 9 IN length of high density perlite or high density calcium silicate at saddle.
 - b. See Specification Section 40 42 00.
 3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of high density perlite or high density calcium silicate at saddle.
- I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.
- J. Pipe Support Spacing:
 1. General:
 - a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
 - b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
 - c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
 2. Steel, stainless steel, cast-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 DEGF.

5. Support each length and every fitting:
 - a. Bell and spigot piping:
 - 1) At least one (1) hanger.
 - 2) Applied at bell.

- b. Mechanical coupling joints:
 - 1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
- 6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
- 7. Provide continuous support for nylon tubing.
- 8. For PVC, FRP and copper piping:
 - a. Provide Unistrut Unicushion wrap of pipe at each support.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
 - 1. Included in this requirement are movements from:
 - a. Trap discharge.
 - b. Water hammer.
 - c. Similar internal forces.
- B. Weld Supports:
 - 1. AWS D1.1.
 - 2. Weld anchors to pipe in accordance with ASME B31.3.
 - 3. AWS D1.6 for stainless steel supports.
- C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
- D. Inspect hangers for:
 - 1. Design offset.
 - 2. Adequacy of clearance for piping and supports in the hot and cold positions.
 - 3. Guides to permit movement without binding.
 - 4. Adequacy of anchors.
- E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.
- F. Anchorage to Concrete- reference Section 03 15 19.
- G. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
 - 1. Install concrete inserts as concrete forms are installed.
- H. Welding:
 - 1. Welding rods: ASTM and AWS standards.
 - 2. Integral attachments:
 - a. Include welded-on ears, shoes, plates and angle clips.
 - b. Ensure material for integral attachments is of good weldable quality.
 - 3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.
- I. Field Painting:
 - 1. Comply with Specification Section 09 96 00.

END OF SECTION

SECTION 40 05 17
PIPE - COPPER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper piping, fittings, and appurtenances.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
 - 4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
 - 5. Section 40 05 07 - Pipe Support Systems.
- C. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
 - b. B16.23, Cast Bronze Solder Joint Drainage Fittings - DWV.
 - c. B16.26, Cast Bronze Alloy Fittings for Flared Copper Tubes.
 - 2. ASTM International (ASTM):
 - a. B32, Standard Specification for Solder Metal.
 - b. B42, Standard Specification for Seamless Copper Pipe, Standard Sizes.
 - c. B88, Standard Specification for Seamless Copper Water Tube.
 - d. B306, Standard Specification for Copper Drainage Tube (DWV).
 - 3. American Welding Society (AWS):
 - a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.

1.2 SUBMITTALS

- A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. See Specification Section 40 05 00.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Copper Tubing:
 - 1. Pressure non-buried: ASTM B88, Type L hard.
 - 2. Pressure buried: ASTM B88, Type K.
 - 3. Non-pressure: ASTM B306.
- B. Copper Pipe: ASTM B42, regular strength.
- C. Fittings:
 - 1. Pressure non-buried: ASME B16.22.
 - 2. Pressure buried: ASME B16.22 or ASME B16.26.
 - 3. Non-pressure: ASME B16.23
- D. Soldering and Brazing:
 - 1. Non-buried:
 - a. ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux up to 180 DEGF water temperature.

- b. At 180 DEGF and above, use brazing alloy with melting temperature above 1000 DEGF and suitable flux.
- 2. Buried: Silver solder per AWS A5.8M/A5.8.
- E. See Piping Schedules in Specification Section 40 05 00.
- F. Unions:
 - 1. Pipe sizes 2 IN and smaller: Copper, ground joint.
 - 2. Pipe sizes 2-1/2 IN and larger: Brass flanged unions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with Specification Section 40 05 00.

3.2 FIELD QUALITY CONTROL

- A. Test piping systems in accordance with Specification Section 40 05 00.
- B. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.
- C. Support exposed piping in accordance with Specification Section 40 05 00 and Specification Section 40 05 07.
- D. Install buried piping in accordance with Specification Section 31 23 33 and Specification Section 40 05 00.

END OF SECTION

SECTION 40 05 19

PIPE - DUCTILE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ductile iron piping, fittings, and appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 00 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
 - b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. ASTM International (ASTM):
 - a. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 3. American Water Works Association (AWWA):
 - a. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
 - b. C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe.
 - c. C606, Standard for Grooved and Shouldered Joints.
 - 4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C105/A21.5, Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
 - c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - e. C150/A21.50, Standard for Thickness Design of Ductile-Iron Pipe.
 - f. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - g. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 00.
 - 3. Certification of factory hydrostatic testing.
 - 4. If mechanical coupling system is used, submit piping, fittings, and appurtenant items which will be utilized to meet system requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Flanged adapters:
 - a. Star.
 - b. Ford.
 - c. Romac.
 - d. Clow.
 - e. Krausz.
 2. Compression sleeve coupling:
 - a. Romac.
 - b. Ford.
 - c. JCM.
 - d. Krausz.
 3. Grooved coupling:
 - a. Victaulic.
 - b. Grinnel.
 - c. Star
 4. Glass lining:
 - a. Ceramic Coating (Non-Stick Glass Lining).
 - b. Permutit (SG-14 Glass Lining).
 5. Insulating couplings:
 - a. Romac.
 - b. Smith-Blair Stle 416.
 - c. Dresser Style 39.
 6. Reducing couplings:
 - a. Romac.
 - b. Ford.
 - c. Krausz.
 - d. JCM.
 7. Transition coupling:
 - a. Ford.
 - b. Romac.
 - c. JCM.
 - d. Krausz.
 8. Restrained glands:
 - a. Sigma
 - b. Ford
 - c. Star
 9. Restrained joints:
 - a. American (Lock Fast) - 12 IN and below.
 - b. U.S. Pipe (TR-Flex) - 4 IN to 54 IN.
 - c. American (Lock Fast) - Above 12 IN.
 10. Mechanical coupling:
 - a. Victaulic (Style 31).
 - b. Tyler.
 11. Restrained joints:
 - a. American (Lock Fast) - 12 IN and below.
 - b. U.S. Pipe (TR-Flex) - 4 IN to 54 IN.
 - c. American (Lock Fast) - Above 12 IN.
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MATERIALS

- A. Ductile Iron Pipe:
 - 1. AWWA/ANSI C115/A21.15.
 - 2. AWWA/ANSI C150/A21.50.
 - 3. AWWA/ANSI C151/A21.51.
- B. Fittings and Flanges:
 - 1. AWWA/ANSI C110/A21.10.
 - 2. AWWA/ANSI C115/A21.15.
 - 3. Flanges drilled and faced per ASME B16.1 for both 125 and 250 PSI applications.
- C. Nuts and Bolts:
 - 1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application.
 - 2. Exposed: Mechanical galvanized ASTM B695, Class 40.
 - 3. Heads and dimensions per ASME B1.1.
 - 4. Threaded per ASME B1.1.
 - 5. Project ends 1/4 to 1/2 IN beyond nuts.
- D. Gaskets: See individual piping system requirements in Section 40 05 00.
- E. If mechanical coupling system is used, utilize pipe thickness and grade in accordance with AWWA C606.
- F. See Piping Schedules in Section 40 05 00.

2.3 MANUFACTURED UNITS

- A. Couplings:
 - 1. Flanged adaptors:
 - a. Unit consisting of steel or carbon steel body sleeve, flange, followers, Grade 30 rubber gaskets.
 - b. Provide units specified in the MANUFACTURERS Article.
 - c. Supply flanges meeting standards of adjoining flanges.
 - d. Rate entire assembly for test pressure specified on piping schedule for each respective application.
 - 2. Compression sleeve coupling:
 - a. Unit consisting of steel sleeve, followers, Grade 30 rubber gaskets.
 - b. Provide units specified in the MANUFACTURERS Article.
 - c. Supply flanges meeting standards of adjoining flanges.
 - d. The working pressure rating of the entire assembly shall be greater than or equal to the test pressure specified on piping schedule for each respective piping application.
 - e. Provide field coating for buried couplings per AWWA C203.
 - 3. Mechanical couplings:
 - a. Use of mechanical couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 40 05 00.
 - b. Utilize units defined in the MANUFACTURERS Article.

2.4 FABRICATION

- A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.
- B. Furnish cast parts with lacquer finish compatible with finish coat.
- C. Glass Lining:
 - 1. Minimum two-coat process.
 - a. Base coat heated to solidly fuse glass to pipe surface.
 - b. Subsequent coat(s) heated to form integral bond with preceding coat.
 - 2. Final finish parameters:

- a. Thickness: 8-12 MILS.
 - b. Hardness: Above 5 on MOHS scale.
 - c. Density: 2.5-3.0 grams per cubic centimeter.
 - d. Metal to lining bonding: Capable of withstanding strain of 0.0001 IN/IN without damage to lining.
3. Complete compatibility between fittings and piping.

2.5 LININGS AND COATINGS

- A. Where specified in piping schedule, provide linings to a minimum thickness of 40 MILS.
- B. Buried pipe and fittings shall have cement lining and asphaltic coating per AWWA/ANSI C104/A21.4.
- C. Exposed pipe and fittings shall have cement lining per AWWA/ANSI C104/A21.4 and factory epoxy coating.

2.6 SOURCE QUALITY CONTROL

- A. Factory Test:
 1. Subject pipe to hydrostatic test of not less than 500 PSI with the pipe under the full test pressure for at least 10 seconds.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Joining Method - Push-On Mechanical (Gland-Type) Joints:
 1. Install in accordance with AWWA/ANSI C111/A21.11.
 2. Assemble mechanical joints carefully according to manufacturer's recommendations.
 3. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint.
 4. Do not overstress bolts.
 5. Where piping utilizes mechanical joints with tie rods, align joint holes to permit installation of harness bolts.
- B. Joining Method - Push-On Joints:
 1. Install in accordance with AWWA/ANSI C151/A21.51.
 2. Assemble push-on joints in accordance with manufacturer's directions.
 3. Bevel and lubricate spigot end of pipe to facilitate assembly without damage to gasket.
 - a. Use lubricant that is non-toxic, does not support the growth of bacteria, has no deteriorating effects on the gasket material, and imparts no taste or odor to water in pipe.
 4. Assure the gasket groove is thoroughly clean.
 5. For cold weather installation, warm gasket prior to placement in bell.
 6. Taper of bevel shall be approximately 30 DEG with centerline of pipe and approximately 1/4 IN back.
- C. Joining Method - Flanged Joints:
 1. Install in accordance with AWWA/ANSI C115/A21.15.
 2. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
 3. Make flange faces flat and perpendicular to pipe centerline.
 4. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
 5. Allow one (1) flange free movement in any direction while bolts are being tightened.
 6. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
 7. Gradually tighten flange bolts uniformly to permit even gasket compression.

- D. Joining Method - Mechanical Coupling Joint:
 - 1. Arrange piping so that pipe ends are in full contact.
 - 2. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
 - 3. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.
- E. Flange Adaptors 12 IN and Less:
 - 1. Locate and drill holes for anchor studs after pipe is in place and bolted tight.
 - 2. Drill holes not more than 1/8 IN larger than diameter of stud projection.
- F. Cutting:
 - 1. Do not damage interior lining material during cutting.
 - 2. Use abrasive wheel cutters or saws.
 - 3. Make square cuts.
 - 4. Bevel and free cut ends of sharp edges after cutting.
- G. Support exposed pipe in accordance with Section 40 05 00.
- H. Install buried piping in accordance with Section 40 05 00.
- I. Install restrained joint systems where specified in Section 40 05 00 under specific piping system.

3.2 FIELD QUALITY CONTROL

- A. Test piping systems in accordance with Section 40 05 00.

END OF SECTION

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SECTION 40 05 23
PIPE - STAINLESS STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Stainless steel tubing, piping, fittings and appurtenances.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
 - b. B31.1, Power Piping.
 - 2. ASTM International (ASTM):
 - a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - c. A312, Standard Specification for Seamless, Welded, and Heavy Cold Worked Austenitic Stainless Steel Pipes.
 - d. A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
 - e. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - f. A530, Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
 - g. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 - h. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 00.
 - 3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - 4. Fabrication details and welding procedure specifications for all work to be done under this Specification Section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tubing:
 - 1. ASTM A269.
 - 2. Filler material: Extra low carbon (ELC) with 0.03 PCT maximum carbon.

- B. Pipe, unless noted otherwise on individual piping system in Specification Section 40 05 00:
 - 1. ASTM A778.
 - 2. ASTM A312.
- C. Pipe Fittings:
 - 1. ASTM A774.
- D. Flanges, unless noted otherwise on individual piping system in Specification Section 40 05 00:
 - 1. Flat faced.
 - 2. Welding neck or slip on type.
 - 3. ASTM A182, Type 316L.
- E. Nuts, Bolts and Washers, unless noted otherwise on individual piping system in Specification Section 40 05 00:
 - 1. ASTM A320, Type 316.
 - 2. Two (2) nuts provided for 1 IN DIA bolt applications and larger.
- F. Expansion Joints, unless noted otherwise on individual piping system in Specification Section 40 05 00:
 - 1. Bellows: Series 300 stainless steel.
 - 2. Liner: Series 300 stainless steel.
 - 3. Flanges: Steel
 - 4. Control Tie-Rods: Steel.
- G. Elastomeric Bellows Type Expansion Joint (for hot air service):
 - 1. Refer to Section 40 05 00 for expansion joints for liquid service.
 - 2. Manufacturers:
 - a. Mercer Series 500 or equal.
 - 3. Two Arch construction.
 - 4. Material: EPDM (tube and cover)
 - 5. Restraint: Provide control rods sized to restrain joint at test pressure.
 - a. Materials: 316 stainless steel.
 - 6. Allow for minimum of 1 IN of lateral movement.
 - 7. Pressure Rating: Working pressure of joint equal or greater than test pressure of connecting piping. Provide minimum 25 PSIG rating.
- H. Gasket Material, unless noted otherwise on individual piping system in Specification Section 40 05 00:
 - 1. Rubber or neoprene.
 - 2. Temperature rating of 250 DEGF.
- I. Flexible Metal Hose:
 - 1. General: Braided stainless steel flexible hose.
 - 2. Connections: Provide ANSI 125 flanged connections.
 - 3. Length: Minimum 12 IN or as noted on the Drawings.
 - 4. Pressure: Working pressure of hose equal or greater than test pressure of connecting piping.

2.2 FABRICATION

- A. All stainless steel tube, piping, fitting products shall be pickled/passivated to remove free iron contamination suffered during the fabrication. Pickling/passivation shall be per the requirements of ASTM A380 following the conclusion of fabrication operations, just prior to shipping.
 - 1. Assemblies passivated following fabrication shall be protected from additional carbon steel surface contamination during all subsequent packing, shipping, handling, and installation operations as described in ASTM A380.
- B. Solvents and acid cleaning solutions shall be controlled and disposed of by the fabricator according to all applicable federal, state, and local pollution control regulations. All tube, piping, fitting product to be immersion pickled subsequent to manufacturing and fabrication operations and prior to shipping.

1. Pickling solution of 6-10 percent nitric acid and 3-4 percent hydrofluoric acid.
 2. Temperature and exact concentrations to be such only a modest etch is produced but all oxidation and ferrous contamination is removed from metal surface.
 3. All pickling solution residues are to be neutralized after pickling.
- C. Diameter tolerance and wall thickness tolerance are to conform to ASTM A530.
- D. Joints:
1. Shop welded circumferential butt weld joints.
 2. ASME B16.1, Class 150.
- E. Elastomeric Bellows Type Expansion Joints:
1. Ensure aerial travel in expansion joints of 3.1 IN minimum for 15,000 cycles or 5.2 IN for 1000 cycles.
 2. Furnish each assembly with a minimum of two control tie rods.
 3. Fabricate with 125 LB flanged end connections.
- F. Expansion Joints:
1. Fabricate for 15 PSI internal pressure and 250 DEGF operation.
 2. Ensure aerial travel in expansion joints of 3.1 IN minimum for 15,000 cycles or 5.2 IN for 1000 cycles.
 3. Furnish each assembly with minimum four control tie rods.
 4. Fabricate with 125 LB flanged end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation, inspect and verify condition of piping and appurtenances.
1. Installation constitutes installer's acceptance of condition for satisfactory installation.

3.2 PREPARATION

- A. Correct defects or conditions which may interfere with or prevent a satisfactory installation.
- B. Ensure ends of pipe to be fitted with flanges have all protrusions ground flush.

3.3 INSTALLATION

- A. Ensure all pipe cutting, threading and jointing conforms to requirements of ASME B31.1.
1. Lubricate all pipe threads with Teflon tape.
- B. Welding:
1. Provide welds sound and free from embedded scale or slag, and tensile strength at weld not less than pipe.
 2. Perform butt welds only with an inert gas shielded process.
 3. Adequate inert gas protection is to be provided to the top and under or backside of the weld to protect from atmospheric contamination.
 4. Filler metal is to be applied to all manually-performed welds appropriate for the base material being welded.
 5. Only inert gas shielded welding processes are to be used for spool fabrication.
 6. Provide butt welds with 100 PCT penetration to the interior or back side of the weld joint.
 7. Weld reinforcement on both sides of the weld are to be smooth, uniform and no more than 1/16 IN in height.
- C. Joining Method - Flanges:
1. Leave 1/8 IN to 3/8 IN flange bolts projecting beyond face of nut after tightening.
 - a. Coordinate dimensions and drillings of flanges with flanges for valves, equipment, and other systems.

- b. Tighten bolts evenly around pipe until following range of torques is achieved:

BOLT SIZE, IN	RANGES OF TORQUE, FT/LBS
5/8	40 - 60
3/4	60 - 90
1	70 - 100
1-1/4	90 - 120

D. Expansion Joints:

1. Install in accordance with manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

- A. Test piping systems in accordance with Specification Section 40 05 00.

3.5 CLEANING

- A. Clean in accordance with Specification Section 40 05 00.

END OF SECTION

SECTION 40 05 24

PIPE - STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel pipe, fittings, and appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 09 96 00 - High Performance Industrial Coatings.
 - 4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
 - b. B1.2, Gages and Gaging for Unified Inch Screw Threads.
 - c. B16.3, Malleable Iron Threaded Fittings.
 - d. B16.5, Pipe Flanges and Flanged Fittings.
 - e. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
 - f. B16.11, Forged Steel Fittings, Socket Welding and Threaded.
 - g. B31.1, Power Piping.
 - h. B31.3, Process Piping.
 - i. B31.9, Building Services Piping.
 - j. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - d. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - e. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - g. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - h. B6, Standard Specification for Zinc.
 - i. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 3. American Water Works Association (AWWA):
 - a. C200, Standard for Steel Water Pipe - 6 IN and Larger.
 - b. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel water Pipeline - Enamel and Tape - Hot Applied.
 - c. C205, Standard for Cement-Mortar Lining and Coating for Steel Water Pipe - 4 IN and Larger - Shop Applied.
 - d. C206, Standard for Field Welding of Steel Water Pipe.

- e. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
- f. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
- g. C209, Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
- h. C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
- i. C606, Standard for Grooved and Shouldered Joints.
- j. M11, Steel Pipe - A Guide for Design and Installation.
- 4. Society of Automotive Engineers (SAE):
 - a. AMS-QQ-P-416, Cadmium Plating Electro deposited.
- B. Qualifications:
 - 1. Application of coal tar lining and coating materials including preparation of surfaces, priming, and lining and coating of pipe, fittings, and specials, in shop, repairs of any damage to lining or coating occurring during shipment or any other time, and field lining and coating of ends where linings or coatings have been held back for welded field joints, shall be done by established and recognized pipe company acceptable to Engineer.
 - 2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 00.
 - 3. Factory test reports.
 - 4. If mechanical grooved type coupling system is used, submit piping, fittings, and appurtenant items which will be utilized.
 - 5. Coating manufacturer's qualifications.
 - 6. Welders certificates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Flanged adapters for 16-IN steel pipe SCH 20 or thicker such as old pipes welded to old headtank:
 - a. Ford Meter Box – Uni-Flange Series 400.
 - 2. Full Face Restrained Flange Adapters:
 - a. Romac – Alpha Series.
 - b. Ford Meter Box – RFA Series.
 - c. Hymax
 - 3. Stainless Steel Restrained Couplings:
 - a. Straub.
 - b. Robar/Arpol.
 - 4. Transition coupling:
 - a. Rockwell (Style 413).
 - b. Dresser (Style 62).
 - 5. Compression sleeve coupling:
 - a. Rockwell (Style 411 (steel)).
 - b. Dresser (Style 38 (steel)).

6. Mechanical couplings and fittings:
 - a. Victaulic (Style 07 or 77).
 - b. S.P. Fittings.
 7. Factory-applied plastic or epoxy coatings:
 - a. "Encoat" Division of Energy Coating Company.
 - b. "Scotchkote" Division of 3M Company.
 8. Flanged steel fittings 6-IN and larger:
 - a. Morrill Industries, Inc.
 - b. Victaulic fittings with Style 741 Flange Adapters may be provided where there are full face flanges to mate to and where there are no rotational forces to resist.
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MATERIALS

- A. All materials used in steel piping systems defined in Section 40 05 00 shall meet or exceed pressure test requirements specified for each respective system.
- B. Steel Pipe (Fabricated Type):
 1. AWWA C200:
 - a. ASTM A36, Grade C steel plate.
 - b. ASTM A283, Grade D steel plate.
 - c. ASTM A572, steel plate.
 - d. ASTM A1011, steel sheet.
- C. Steel Pipe (Mill Type): ASTM A53, Type E or S SCH 40 stainless 316 steel where Drawings indicate (un-painted) for effluent drumfilter spray pump discharge piping (150 psi 316 stainless steel threaded fittings shall be provided)).
- D. Fittings (For Fabricated Pipe): See part 2.4 Fabrication.
- E. Fittings For Mill Type Pipe 5-IN and smaller (see Part 2.4 Fabrications for 6-IN and larger):
 1. ASTM A234.
 2. ASME B16.3, ASME B16.5, ASME B16.9, ASME B16.11.
- F. Flanges (Fabricated Pipe):
 1. Flange material: ASTM A283, Grade C or D, ASTM A181, Grade 1.
 2. Flange finish: Flat faced.
- G. Flanges (Mill Type Pipe):
 1. ASME B16.5.
 2. Flat faced.
 3. Slip-on flanges.
- H. Nuts and Bolts:
 1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application
 2. Exposed: Mechanical galvanized ASTM B695, Class 40.
 3. Heads and dimensions per ASME B1.1.
 4. Threaded per ASME B1.1.
 5. Project ends 1/4 to 1/2 IN beyond nuts.
- I. Where galvanized steel pipe is indicated on Drawings pipe shall have hot-dip Galvanized coatings and linings.
- J. Gaskets: See individual piping systems in Section 40 05 00.

2.3 MANUFACTURED UNITS

- A. Couplings:
 1. Flanged adapters:
 - a. Iron, steel or carbon steel body sleeve, flange, followers and Grade 30 rubber gaskets.

- b. Factory epoxy coating and stainless steel bolts.
 - c. Provide units specified in Article 2.1.
 - d. Flanges meeting standards of adjoining flanges.
 - e. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
- 2. Stainless Steel Restrained Couplings:
 - a. All 304 or 316 stainless steel except resilient seals.
 - b. Rated at least 150 psi.
- 3. Compression sleeve coupling:
 - a. Steel sleeve, followers Grade 30 and rubber gaskets.
 - b. Provide units specified in Article 2.1.
 - c. Flanges meeting standards of adjoining flanges.
 - d. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
 - e. Provide field coating for buried couplings per AWWA C203.
- 4. Mechanical coupling joint:
 - a. Use of mechanical grooved (AWWA C606) type couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 40 05 00.
 - b. Utilize units defined in Article 2.1.

2.4 FABRICATION

- A. Provide piping (mill or fabricated) and fittings for use in this Project with minimum wall thicknesses as follows:
 - 1. 1/8 - 5 IN DIA pipe: Schedule 40.
 - 2. 6 - 10 IN DIA pipe: 0.120 IN.
 - 3. 12 - 14 IN DIA pipe: 0.188 IN.
 - 4. 16 - 48 IN DIA pipe: 0.188 IN.
 - 5. Sizes through 24 IN are nominal OD.
 - 6. Wall thicknesses indicated are for standard weight pipe.
 - a. Design pipe in accordance with operating pressures shown in Piping Schedules for a design stress limited to 50 PCT of yield.
- B. Fittings (see also Pipe and Fitting Linings and see also Pipe and Fitting Coatings):
 - 1. Rated at least 150 psi, grooved or flanged.
 - 2. Assure ratio of radius of bend to diameter of pipe equal to or greater than 1.0.
 - 3. Class 150 ANSI flanges.
- C. Pipe and Fitting Linings:
 - 1. Factory fusion bonded epoxy (NSF 61 approved).
- D. Pipe and Fitting Coatings:
 - 1. Factory fusion bonded epoxy with polyester topcoat for UV resistance if outdoors or.
 - 2. High Performance Industrial Coatings in accordance with Section 09 96 00 or.

2.5 SOURCE QUALITY CONTROL

- A. Testing:
 - 1. Shop hydrostatic test fabricated steel pipe and fittings.
 - 2. Field hydrostatic test all pipe as specified in Section 40 05 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Joining Methods - Flanges:
 - 1. Facing method:
 - a. Insert slip-on flange on pipe.

- b. Assure maximum tolerances for flange faces from normal with respect to axis of pipe is 0.005 IN per foot of flange diameter.
 - c. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.
- 2. Joining method:
 - a. Leave 1/8 to 3/8 IN of flange bolts projecting beyond face of nut after tightening.
 - b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
 - c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
 - 1) Allow one flange free movement in any direction while bolts are being tightened.
 - d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
 - e. Gradually tighten flange bolts uniformly to permit even gasket compression.
 - f. Do not overstress bolts to compensate for poor installation.
- C. Joining Method - Welded Joints:
 - 1. Perform welding in accordance with AWWA C206 and this Section.
 - 2. For flange attachment perform in accordance with AWWA C207.
 - 3. Have each welding operator affix an assigned symbol to all his welds.
 - a. Mark each longitudinal joint at the extent of each operator's welding.
 - b. Mark each circumferential joint, nozzle, or other weld into places 180 DEG apart.
 - 4. Welding for all process piping shall conform to ASME B31.3.
 - a. Welding of utility piping 125 PSI and less shall be welded per ASME B31.9.
 - b. Utility piping above 125 PSI shall conform to ASME B31.1.
 - 5. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications.
 - 6. Weldolets may be used for 5 IN and larger pipe provided all slag is removed from inside the pipe.
 - 7. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer.
 - 8. Use all long radius welding elbows for expansion loops and bends.
 - 9. Use long radius reducing welding elbows 90 DEG bends and size changes are required.
- D. Joining Method - Couplings:
 - 1. Compression sleeve:
 - a. Install coupling to allow space of not less than 1/4 IN but not more than 1 IN.
 - b. Provide harnessed joint.
 - 1) Use joint harness arrangements detailed in AWWA M11.
 - c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 40 05 00 and allow for expansion of pipe.
 - d. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type.
 - e. Grind smooth welds the length of one coupling on either side of joint to be fitted with any coupling.
 - f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.
 - 2. Mechanical coupling:
 - a. Arrange piping so that pipe ends are in full contact.
 - b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
 - c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.
- E. Joining Method - Threaded and Coupled (T/C):
 - 1. Provide T/C end conditions that meet ASME B1.2 requirements.

2. Furnish pipe with factory-made T/C ends.
3. Field cut additional threads full and clean with sharp dies.
4. Leave not more than three pipe threads exposed at each branch connection.
5. Ream ends of pipe after threading and before assembly to remove burrs.
6. Use Teflon thread tape on male thread in mating joints.

F. Support exposed piping in accordance with Section 40 05 00.

G. Install buried piping per Section 40 05 00.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

END OF SECTION

SECTION 40 05 31

PIPE - PLASTIC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic pipe.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. See Specification Section 40 05 00.
- B. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. PVC (polyvinyl chloride) materials:
 - 1) D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 2) D1785, Standard Specification for Poly(Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
 - 3) D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - 4) D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 5) D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 6) D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - 7) D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - 8) F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 9) F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
 - 10) F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
 - 11) F949, Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
 - b. Installation:
 - 1) D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 2. American Water Works Association (AWWA):
 - a. PVC (polyvinyl chloride) materials:
 - 1) C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN Through 12 IN, for Water Distribution.
 - 2) C905, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 IN through 48 IN, for Water Transmission and Distribution.
 - b. Polyethylene (PE) materials:
 - 1) C901, Standard for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 IN through 3 IN, for Water Service.
 - 3. NSF International (NSF).

1.3 SUBMITTALS

- A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. See Specification Section 40 05 00.

PART 2 - PRODUCTS

2.1 PVC PRESSURE PIPING (EXPOSED)

- A. General:
 - 1. Provide Schedule 40 or 80 pipe with the same Schedule fittings and appurtenances to locations shown on Drawings.
 - 2. Furnish materials in full compliance to following material specifications:
 - a. Manufacture pipe, fittings and appurtenances from polyvinyl chloride (PVC) compound which meets the requirements of Type 1, Grade 1 (12454-B) Polyvinyl Chloride as outlined in ASTM D1784.
 - b. Manufacture pipe, fittings and valves from materials that have been tested and approved for conveying potable water by the NSF.
- B. Pipe:
 - 1. Furnish pipe meeting requirements of ASTM D1785.
 - 2. Pipe 2 IN and less to be solvent welded.
 - 3. Pipe larger than 2 IN may be either flanged or solvent welded unless shown otherwise on Drawings.
- C. Fittings: Provide ASTM D2467 PVC socket type fittings having the same pressure and temperature rating as the pipe. Provide bolt-on PVC saddles where Drawings indicate. They shall have 316 stainless steel bolts and resilient seals. Provide PVC socket tank adapters (bulkheads) at round tanks and threaded polyethylene, PVC, stainless or aluminum tanks adapter (bulkhead) at mobile tank.
- D. Flanges/Unions:
 - 1. Furnish flanges and unions at locations shown on Drawings.
 - 2. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
 - 3. For pipe larger than 2 IN, provide 150 LB socket type PVC flange.
 - 4. For pipe 2 IN and less, provide socket type PVC union with Buna O-rings.
 - 5. Use flat, full faced natural rubber gaskets at flanged connections.
 - a. Furnish heavy hex head bolts, each with one heavy hex nut, ASTM F593 Type 316 stainless steel.
 - 6. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.
- E. Installation:
 - 1. Field threading PVC will not be permitted.
 - a. Perform required threaded connections or attachments by the use of factory molded socket by threaded adapters.
 - b. Female adapters are not acceptable.
 - 2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
 - a. Continuously support PVC piping at liquid operating temperatures in excess of 100 DEGF.
 - b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
 - c. Support riser clamps on spring hangers.
 - d. Do not clamp PVC tightly or restrict movement for expansion and contraction.

2.2 PRESSURE PIPING (UNDERGROUND)

- A. Materials: Furnish materials in full compliance with following requirements:
 - 1. 4-12 IN: AWWA C900 PVC with Pressure Class of 150 PSI.
 - 2. 14-36 IN: AWWA C905 PVC DR-25.
 - 3. 1/2-12 IN: ASTM D2241 PVC, Type 1, Grade 1 (12454-B) designated as PVC 1120 with pressure rating of 160 - 200 - 250 PSI per Table XI, ASTM D2241.
 - 4. Joints for polyethylene pipe shall be fusion type in accordance with AWWA C901.
 - 5. Joints for PVC pipe shall be the elastomeric-gasket type with a pressure rating not less than pipe pressure rating meeting performance requirements of ASTM D3139.

2.3 PVC DRAINAGE, SEWER PIPING

- A. Materials:
 - 1. Furnish materials in full compliance to the following material specification.
 - 2. PVC pipe shall be rigid, unplasticized polyvinyl chloride (PVC) made of PVC plastic having a cell classification of 12454-B or 12454-C as described in specification ASTM D1784.
 - 3. The requirements of this Specification are intended to provide for pipe and fittings suitable for non-pressure drainage of wastewater and surface water.
 - 4. Joining systems shall consist of an elastomeric gasket joint meeting requirements of ASTM D3212.
 - 5. Supply to the Engineer all information and sample of joining method for his evaluation.
 - a. Only joining methods acceptable to the Engineer will be permitted.
 - 6. Provide pipe and fittings meeting or exceeding the following requirements:
 - a. 4-27 IN DIA: ASTM D3034 and ASTM F679, SDR 35.
 - b. 8-30 IN DIA: ASTM F794.
 - c. 4-18 IN DIA: ASTM F949.
 - 7. Ensure impact strengths and pipe stiffnesses in full compliance to these Specifications.
- B. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
 - 1. Provide for a maximum deflection of not more than 5 PCT.
- C. Infiltration and Exfiltration:
 - 1. The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
 - 2. For exfiltration, all the pipe and fittings shall exceed performance requirements by an air test procedure as specified in Section 40 05 00.
 - 3. Observe full instructions of the Engineer for carrying of testing procedures.
 - a. Perform tests only during presence of the Engineer or his authorized representative.
 - 4. Should any test on any section of pipeline disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.
- D. Deflection:
 - 1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
 - 2. Pipe with deflection exceeding 5 percent of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 percent.
 - 3. Any repaired pipe shall be retested.

2.4 PVC TUBING

- A. General: Provide nylon tubing with fittings and appurtenances as shown on Drawings.
- B. Materials:
 - 1. Furnish clear outer braided tubing with braid outside the walls.
 - 2. Have tubing manufactured of nylon with working temperatures from 5 to 180 DEGF.
 - 3. Design tubing with a minimum safety factor of 4 to 1 ratio of burst pressure to working pressure at maximum temperature.
 - 4. Provide tubing with working pressure of 75 PSI at 180 DEGF.
 - 5. Ensure that tubing is self-extinguishing and fire resistant.
- C. Fittings:
 - 1. Install tubing with nylon fittings and connectors.
 - 2. Use barbed type adapters with stainless steel clamps.
 - 3. Provide fittings capable of withstanding temperatures from a -70 to 250 DEGF.
 - 4. Ensure fittings have the same pressure and temperature rating as the tubing.

PART 3 - EXECUTION

3.1 IDENTIFICATION

- A. Identify each length of pipe clearly at intervals of 5 FT or less.
 - 1. Include manufacturer's name and trademark.
 - 2. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

3.2 PRESSURE PIPING (UNDERGROUND)

- A. Installation:
 - 1. Field threading of PVC pipe will not be permitted.
 - 2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

3.3 PVC DRAINAGE, SEWER PIPING AND UNDERGROUND AIR DUCTS

- A. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
 - 1. Provide for a maximum deflection of not more than 5 PCT.
- B. Infiltration and Exfiltration:
 - 1. The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
 - 2. For exfiltration, all the pipe and fittings shall exceed performance requirements by the test procedure as specified in Section 40 05 00.
 - 3. Observe full instructions of the Engineer for carrying of testing procedures.
 - a. Perform tests only during presence of the Engineer or his authorized representative.
 - 4. Should any test on any section of pipe line disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.
- C. Deflection:
 - 1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
 - 2. Pipe with deflection exceeding 5 PCT of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 PCT.
 - 3. Any repaired pipe shall be retested.

3.4 PVC TUBING

A. Fittings:

1. Install tubing with nylon fittings and connectors.
2. Use barbed type adapters with stainless steel clamps.
3. Provide fittings capable of withstanding temperatures from a -70 to 250 DEGF.
4. Ensure fittings have the same pressure and temperature rating as the tubing.

B. Trays:

1. Flat smoothed bottom tray for supporting flexible hoses when there is a chance that the hoses may pulse or move; specify a flat smoothed bottom tray.

END OF SECTION

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SECTION 40 05 51
VALVES - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Valving, actuators, and valving appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 09 96 00 - High Performance Industrial Coatings.
 - 4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B1.20.1, Pipe Threads, General Purpose.
 - b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - c. D638, Standard Test Method for Tensile Properties of Plastics.
 - d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
 - e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - 3. American Water Works Association (AWWA):
 - a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
 - b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - c. C504, Standard for Rubber-Seated Butterfly Valves.
 - d. C507, Standard for Ball Valves, 6 IN through 48 IN (150 MM through 1200 MM).
 - e. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
 - f. C550, Standard for Protective Coatings for Valves and Hydrants.
 - g. C606, Standard for Grooved and Shouldered Joints.
 - 4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. MG 1, Motors and Generators.
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).

1.3 DEFINITIONS

- A. The following are definitions of abbreviations used in this Specification Section or one of the individual valve sections:
 - 1. CWP: Cold water working pressure.
 - 2. SWP: Steam working pressure.
 - 3. WOG: Water, oil, gas working pressure.
 - 4. WWP: Water working pressure.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Valve pressure and temperature rating.
 - d. Valve material of construction.
 - e. Special linings.
 - f. Valve dimensions and weight.
 - g. Valve flow coefficient.
 - h. Wiring and control diagrams for electric or cylinder actuators.
 - i. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70.
 - 3. Test reports.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. Verification from valve actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the valve actuator responds correctly to the valve position command.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

- A. Refer to individual valve Specification Sections.

2.3 VALVE ACTUATORS

- A. Valve Actuators - General:
 - 1. Provide actuators as shown on Drawings or specified.
 - 2. Counter clockwise opening as viewed from the top.
 - 3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
 - 4. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 FT-pounds torque on the operating nut.
 - 5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.

6. Extension stem:
 - a. Install where shown or specified.
 - b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
 - c. Pin all stem connections.
 - d. Center in valve box or grating opening band with guide bushing.
- B. Buried Valve Actuators:
1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum diameter, 3/16 IN minimum thickness, and identifying cast iron cover rated for traffic load.
 2. Box base to enclose buried valve gear box or bonnet.
 3. Provide 2 IN standard actuator nuts complying with AWWA C500, Section 3.16.
 4. Provide at least two tee handle keys for actuator nuts, with 5 FT extension between key and handle.
 5. Extension stem:
 - a. Provide for buried valves greater than 1.5 FT below finish grade.
 - b. Extend to within 6 IN of finish grade.
 6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.
- C. Plastic Valve Vault:
1. Provide in non-traffic areas only on valve applications 3-1/2 IN and less.
 2. Nominal 7-1/2 IN DIA top section.
 3. Design unit for screw type extension section having nominal 9 IN DIA bell.
 4. Cast iron ring and lid.
 5. Constructed of injection molded polyolefin compound with fibrous inorganic component reinforcing and UV stabilization.
 6. Armor Access Boxes.
- D. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric or cylinder actuators.
 2. Provide handwheels for gate and globe valves.
 - a. Size handwheels for valves in accordance with AWWA C500.
 3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN DIA and smaller.
 - a. Lever actuators for butterfly valves shall have a minimum of five (5) intermediate lock positions between full open and full close.
 - b. Provide at least two (2) levers for each type and size of valve furnished.
 4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 IN DIA and larger.
 5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
 6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
 7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
 - a. Cadmium-plated chain looped to within 3 FT of finish floor.
 - b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
 - c. For smaller valves with lever or handle operators, provide offset tee handles with attached chain for operation from the operating floor.
 8. Provide cast iron floor stands where shown on Drawings.
 - a. Stands to be furnished by valve manufacturer with actuator.
 - b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.
- E. Valve Lockout Devices:
1. Device manufactured from same material as valve operator, preventing access to valve operator, to accept lock shackle.

2.4 FABRICATION

- A. End Connections:
 - 1. Provide the type of end connections for valves as required in the Piping Schedules presented in Section 40 05 00 or as shown on the Drawings.
 - 2. Comply with the following standards:
 - a. Threaded: ASME B1.20.1.
 - b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
 - c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
 - d. Soldered: ASME B16.18.
 - e. Grooved: Rigid joints per Table 5 of AWWA C606.
- B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.
- C. Nuts, Bolts, and Washers:
 - 1. Wetted or internal to be bronze or stainless steel.
 - a. Exposed to be zinc or cadmium plated.
- D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.
- E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Painting Requirements: Comply with Section 09 96 00 for High Performance Industrial Coatings.
- C. Setting Buried Valves:
 - 1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
 - 2. Set valves and valve boxes plumb.
 - 3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
 - 4. Install in closed position.
 - 5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
 - 6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.
- D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.
- E. For grooved coupling valves, install rigid type couplings or provide separate support to prevent rotation of valve from installed position.
- F. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.
- G. For threaded valves, provide union on one (1) side within 2 FT of valve to allow valve removal.
- H. Install valves accessible for operation, inspection, and maintenance.

3.2 ADJUSTMENT

- A. Adjust valves, actuators and appurtenant equipment to comply with Section 01 75 00.
 - 1. Operate valve, open and close at system pressures.

END OF SECTION

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SECTION 40 05 52
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Air release and vacuum relief valves.
 - 2. Yard Hydrants
 - 3. Curb Stops
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. American Water Works Association (AWWA):
 - a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
 - b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.
 - 3. Canadian Standards Association (CSA).
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 AIR RELEASE AND VACUUM RELIEF VALVES

- A. General: Conform to AWWA C512.
- B. General: Conform to AWWA C512.
 - 1. Water
 - a. Air Release Valve:
 - 1) Acceptable manufacturers:

- a) APCO 200A.
 - b) GA Industries, Figure 920.
 - 2) Materials:
 - a) Body and cover: Cast iron or semi-steel.
 - b) Float: Stainless steel.
 - c) Linkage and trim: Bronze or stainless steel.
 - 3) Design requirements:
 - a) Size: 1 IN.
 - b) Working pressure: 100 PSI.
 - c) Release 10 CUFTM at 10 PSI differential at 150 PSI line pressure.
 - b. Air and Vacuum Valve:
 - 1) Acceptable manufacturers:
 - a) APCO Series 1900.
 - b) GA Industries, Figure 992.
 - 2) Materials:
 - a) Body and cover: Cast iron.
 - b) Float: Stainless steel.
 - c) Seat: Buna-N.
 - 3) Design requirements:
 - a) Size: 1 1/2 IN.
 - b) Working pressure: 100 PSI.
 - c) Air vacuum capacity: 100 SCFM at 5 PSI differential from atmospheric.
 - d) Provide isolation valve.
 - c. Combination Air Release and Vacuum Valve:
 - 1) Acceptable manufacturers:
 - a) GA Industries, Figure 945 or 960,
 - b) APCO Series S-140C (1 IN-4 IN).
 - 2) Materials:
 - a) Body and cover: Cast iron.
 - b) Float, linkage and hardware: Stainless steel.
 - c) Seat: Buna-N.
 - 3) Design requirements:
 - a) Size: 1 1/2 IN [As shown].
 - b) Working pressure: 100 PSI.
 - c) Release 10 CUFTM at 10 PSI differential at 150 PSI line pressure.
 - d) Air vacuum capacity: 100 SCFM at 5 PSI differential from atmospheric.
 - e) Provide isolation valve, type as shown.
2. Wastewater:
- a. Air Release Valve:
 - 1) Acceptable manufacturers:
 - a) GA Industries, Figure 925 or 927.
 - b) APCO S-400.
 - 2) Materials:
 - a) Body and cover: Cast iron or semi-steel.
 - b) Float and linkage: Stainless steel.
 - c) Seat: Viton or Buna-N.
 - 3) Design requirements:
 - a) Working pressure: 100 PSI.
 - b) Release 10 CUFTM at 10 PSI differential at 75 PSI line pressure.
 - c) Inlet 2 IN NPT, outlet 1/2 IN NPT.
 - d) Flush accessories:
 - (1) Inlet shut-off valve.
 - (2) Blow-off valve.
 - (3) Clear water inlet valve.
 - (4) Hose and quick disconnect coupling.
 - e) Provide isolation valve, type as shown.

- b. Air and Vacuum Valve:
 - 1) Acceptable manufacturers:
 - a) APCO Series S-401 or S-404.
 - b) GA Industries, Figure 993.
 - 2) Materials:
 - a) Body and cover: Cast iron.
 - b) Float: Stainless steel.
 - c) Seat: Buna-N.
 - 3) Design requirements:
 - a) Size: 1 1/2 IN [As shown].
 - b) Working pressure: 100 PSI.
 - c) Air vacuum capacity: 100 SCFM at 5 PSI differential from atmospheric.
 - d) Provide isolation valve, type as shown.
 - e) Flush accessories:
 - (1) Blow-off valve.
 - (2) Clean water inlet valve.
 - (3) Hose and quick connect coupling.
- c. Combination Air Release and Vacuum Valve:
 - 1) Acceptable manufacturers:
 - a) APCO S-440.
 - b) GA Industries, Figure 942.
 - c) Crispin USL20B.
 - 2) Materials:
 - a) Body and cover: Cast iron.
 - b) Float: Stainless steel.
 - (1) Seat: Buna-N.
 - 3) Design requirements:
 - a) Size: 1 1/2 IN [As shown].
 - b) Working pressure: 100 PSI.
 - c) Air vacuum capacity: 5 SCFM at 5 PSI differential from atmospheric.
 - d) Provide isolation valve, type as shown.
 - e) Flush accessories:
 - f) Blow off valve.
 - g) Clear water inlet valve.
 - h) Hose and quick connect coupling.
- 3. Reclaim Water – Combination Air valve
 - a. Designed for raw water, polypropylene float, 3-150 psi operating pressure, nonmetallic seals, inlet size per drawings, clamped two-piece reinforced nylon body, stainless steel body drain ball valve.
 - b. ARI USA Inc. Model D-021

2.3 NON-FREEZE HYDRANTS

- 1. Size: As shown on Drawings
- 2. Burial Depth: As shown on Drawings
- 3. Pressure Rating: 125 psi
- 4. Acceptable Manufacturers:
 - a. Woodford
 - b. Zurn
 - c. Wade

2.4 CURB STOP VALVES

- 1. Size: As shown on Drawings
- 2. Body: Bronze
- 3. Pressure Rating: 125 psi
- 4. Accessories:
 - a. Extension Rod

- b. Cast Iron Valve Box
- c. Tee Handle Key
- 5. Acceptable Manufacturers:
 - a. Mueller Oriseal III
 - b. Legend Valve
 - c. Ford

2.5 ACCESSORIES

- A. Furnish any accessories required to provide a completely operable valve.

2.6 FABRICATION

- A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.
- B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.7 SOURCE QUALITY CONTROL

- A. Shop hydrostatically test to piping system test pressure.

2.8 MAINTENANCE MATERIALS

- A. Provide one (1) set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: See Specification Section 40 05 51.
- B. Air Release, Vacuum Relief, and Pressure Relief Valves:
 - 1. Pipe exhaust to a suitable disposal point.
 - 2. Where exhausted to a trapped floor drain, terminate exhaust line 6 IN minimum above floor.
- C. Float-Operated Valves: Install baffle around float to minimize turbulence adjacent to float.

3.2 FIELD QUALITY CONTROL

- A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.
- B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

SECTION 40 05 61

GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gate valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. American Water Works Association (AWWA):
 - a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - b. C504, Standard for Rubber-Seated Butterfly Valves.
 - c. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
 - d. C515, Standards for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Systems.
 - e. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
 - b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

- A. OS&Y: Outside Screw and Yoke.
- B. NRS: Non-rising Stem.
- C. RS: Rising Stem.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 VALVES: WATER, STEAM CONDENSATE, STEAM TO 125 PSI, AIR; 2-1/2 IN AND SMALLER

- A. Class 125 bronze gate valve.
- B. Comply with MSS SP-80.
- C. Materials:
 - 1. Body, bonnet, wedge: Bronze.
 - 2. Stem: Silicon bronze.
 - 3. Packing: Aramid fibers with graphite (Kevlar®).
- D. Design Requirements:
 - 1. 125 PSI steam, 200 PSI non-shock WOG.
 - 2. Screw in bonnet, non-rising stem, solid wedge.
- E. Manufacturers:
 - 1. Nibco.
 - 2. Stockham.

2.3 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

- A. Double Disc Gate Valve, 3 to 12 IN (Water Application):
 - 1. Comply with AWWA C500.
 - 2. Materials:
 - a. Seating surfaces, stems, stem nut: Bronze.
 - b. Body, disc: Cast iron.
 - 3. Design requirements:
 - a. 200 PSI working pressure.
 - b. Buried: NRS, O-ring stem seal, 2 IN operation nut.
 - c. Exposed: NRS, O-ring stem seal, handwheel.
 - 4. Acceptable manufacturers:
 - a. American Flow Control.
 - b. Clow.
 - c. M&H.
 - d. Mueller.
- B. Resilient Wedge Gate Valves, 2 to 48 IN (Water, Wastewater Application):
 - 1. Comply with AWWA C509.
 - 2. Materials:
 - a. Stem and stem nut
 - 1) Wetted bronze parts in low zinc bronze.
 - 2) Aluminum bronze components: Heat treated per AWWA C504.
 - b. Body, gate: Cast or. Ductile iron.
 - c. Resilient wedge: Fully encapsulated rubber wedge.
 - 3. Design requirements:
 - a. Minimum 150 PSIG working pressure.
 - b. Buried: NRS, O-ring stem seal, 2 IN square operating nut.
 - c. Exposed: OS&Y, stuffing box stem seal, handwheel.
 - d. Counter clockwise open rotation.

- e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
 - 1) Comply with AWWA C550.
 - 4. Acceptable manufacturers:
 - a. Matco-Norca.
 - b. Mueller.
 - c. American Flow Control.
 - d. M & H.
- C. Double Disc Gate Valves, 14 to 48 IN (Water, Wastewater Application):
 - 1. Comply with AWWA C500.
 - 2. Materials:
 - a. Seating surfaces, stem, stem nut:
 - b. Body, discs: Cast iron.
 - 3. Design requirements:
 - a. 150 PSI working pressure.
 - b. NRS O-ring stem seal.
 - c. Provide gear actuator, 20 IN and larger valves.
 - d. Provide roller tracks and scrapers for horizontal valves size 16 IN and larger.
 - e. Provide bypass valve sized per AWWA C500.
 - 4. Acceptable manufacturers:
 - a. Clow.
 - b. Mueller.
 - c. American Flow Control.
 - d. M & H.
- A. Knife Gate Valves, 2 to 36 IN (Water Application):
 - 1. Valve shall be suitable for moderate throttling and have manufacturer documentation supporting such.
 - 2. Lugged body. Full port.
 - 3. Sealed Bonnet
 - 4. Features:
 - a. Wetted parts: Stainless steel. Gate shall be 316 SS.
 - b. Packing: PTFE impregnated fiber.
 - c. Stem: Stainless steel, double pitch thread.
 - d. Resilient seat.
 - e. Epoxy coated iron wheel.
 - 5. Design requirements:
 - a. Working pressure at least 125 psi WOG non-shock.
 - 6. Acceptable manufacturers:
 - a. Velan.
- B. PVC Gate Valves:
 - 1. PVC body with ANSI flanges. Full port
 - 2. EPDM seat, position indicator, wheel
 - 3. Working pressure at least 150 psi.
 - 4. Designed for throttling. Submit pre-published literature attesting to such.
 - 5. Acceptable manufacturers:
 - a. ASAHI America.
 - b. Chemline.

2.4 VALVES: STEAM, 125 TO 200 PSI

- A. 2 IN and Smaller:
 - 1. Class 300 bronze gate valve.
 - 2. 300 PSI steam, 600 PSI WOG, (non-shock).
 - 3. Comply with MSS SP-80.
 - 4. Materials:

- a. Body, bonnet, wedge: Bronze.
 - b. Stem: Silicon bronze alloy.
 - c. Packing: Teflon or TFE impregnated fiber.
 - 5. Design requirements:
 - a. Union bonnet, rising stem, solid wedge disc, handwheel.
 - 6. Acceptable manufacturers:
 - a. Nibco.
 - b. Stockham.
- B. 2-1/2 IN and Larger:
- 1. Class 250 iron body gate valve.
 - 2. 250 PSI steam, 500 PSI WOG (non-shock).
 - 3. Comply with MSS SP-70.
 - 4. Materials:
 - a. Body: Cast iron, cast bronze trim.
 - b. Stem: Silicon copper alloy.
 - c. Packing: Teflon or TFE impregnated fiber.
 - 5. Design requirements:
 - a. Bolted bonnet, OS&Y, solid wedge disc, handwheel.
 - 6. Acceptable manufacturers:
 - a. Nibco.
 - b. Stockham.

2.5 ACCESSORIES

- A. Refer to Drawings and valve schedule for type of actuators.
 - 1. Furnish actuator integral with valve.
- B. Refer to Specification Section 40 05 51 for actuator requirements.

2.6 FABRICATION

- A. General:
 - 1. Provide valves with clear waterways the full diameter of the valve.
- B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 40 05 51.
- B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.
- C. Do not install gate valves inverted or with the stems sloped more than 45 DEG from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

SECTION 40 05 62

PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plug valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - 2. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - b. A536, Standard Specification for Ductile Iron Castings.
 - c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - 3. American Water Works Association (AWWA):
 - a. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves
 - b. C504, Standard for Rubber-Seated Butterfly Valves

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. See Specification Section 40 05 51.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 NON-LUBRICATED ECCENTRIC PLUG VALVES (SEWAGE, SLUDGE, SEWAGE GAS APPLICATIONS)

- A. Manufacturers:
 - 1. DeZurik.
 - 2. Henry Pratt.
 - 3. Millikin.
 - 4. ValMatic.

- B. Materials:
1. Body: Cast-iron ASTM A126, Class B.
 2. Plug: One or two-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
 3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
 4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
 5. Valve seats: Welded-in overlay of 90 PCT nickel, (minimum 1/8 IN thick).
 6. Stem seal: Nitrile butadiene packing or Buna-N dual U-cups or bronze cartridge double O-rings with lower grit seal O-ring per AWWA C504, Section 3.7.

2.3 NON-LUBRICATED ECCENTRIC PLUG (HEATING-COOLING WATER APPLICATIONS)

- A. Manufacturers:
1. DeZurik Figure 499.
 2. Millikin Series 603.
 3. Victaulic Series 365.
- B. Materials:
1. Body: Cast iron, ASTM A126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Bearings: Bronze or nickel.
 4. Plug seal: Isobutene-isoprene (250 DEGF).

2.4 ACCESSORIES

- A. Refer to Drawings and valve schedule for type of actuator.
1. Furnish actuator integral with valve.
- B. Refer to Specification Section 40 05 51 for actuator requirements.

2.5 DESIGN REQUIREMENTS

- A. Non-Lubricated Eccentric Plug Valves (Wastewater, Sludge):
1. Port area:
 - a. Valves 4 IN through 20 IN: Equal to or exceed 80 PCT of full pipe area.
 - b. Valves greater than 20 IN: 100 PCT equivalent full pipe area.
 2. Valve body: Fitted with bolted bonnet.
 3. End connections: See Specification Section 40 05 51.
 4. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
 5. Designed for seating drip tight in any flow direction.
 6. Rating:
 - a. 1/2 through 12 IN, 175 PSI working pressure.
 - b. 14 through 36 IN, 150 PSI working pressure.
 - c. Three-way valves, 125 PSI working pressure.
 7. Actuator:
 - a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
 - b. Direct lever.
 - c. Positive identification on actuator indicating valve position.
- B. Non-Lubricated Eccentric Plug Valve-(Heating-Cooling water applications):
1. Port area: Valves 1/2 IN through 2-1/2 IN: Equal to or exceed 100 PCT of full pipe area.
 2. Valve body: Fitted with threaded bonnet or bolted bonnet.
 3. End connections:
 - a. Flanges: In full accordance with ASME B16.1, Class 125 including facing, drilling and thickness.
 - b. Threaded connection: In full compliance with NPT.

4. Stem seal: Self-adjusting U-cups or multiple O-ring seals.
5. Shut-off: Designed for setting drip-tight at the full rated pressure.

2.6 FABRICATION

- A. See Specification Section 40 05 51.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 40 05 51.
- B. Install valves with valve stem horizontal, plug seat on inlet side and with plug rotating up into the open position for valves in horizontal lines.
- C. Install valve with actuator above pipe or plug centerline.

END OF SECTION

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SECTION 40 05 63

BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - e. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 2. American Water Works Association (AWWA):
 - a. C507, Standard for Ball Valves, 6 IN through 48 IN.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-110, Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

- A. PVDF: Polyvinylidene fluoride.
- B. PTFE: Polytetrafluoroethylene.
- C. RPTFE: Reinforced PolyTetraFluoroEthylene.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
 - 3. Test results for AWWA valves.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 METALLIC BALL VALVES 1/4 TO 3 IN DIA

- A. Comply with MSS SP-110.
- B. Manufacturers:
 - 1. Apollo.
 - 2. Jamesbury.
 - 3. Watts.
 - 4. Stockham.
 - 5. Nibco.
- C. Materials (All Stainless Steel):
 - 1. Body: Three-part stainless steel, ASTM A351 CF8M.
 - 2. Ball: Stainless steel ASTM A276.
 - 3. Seats: RPTFE.
- D. Design Requirements:
 - 1. Rated for a minimum of:
 - a. 500 PSI CWP.
 - b. 150 PSI of saturated steam.
 - c. 29 IN vacuum.
 - 2. Two-position lockable handle.
 - 3. Stem with blowout-proof design.
 - 4. Balancing stop for all applications.
 - 5. Bodies with mounting pad for applications requiring actuators.

2.3 PLASTIC BALL VALVES: 1/2 IN TO 4 IN DIA

- A. Manufacturers:
 - 1. Chemtrol/NIBCO.
 - 2. Spears.
 - 3. ASAHI/America.
- B. Materials:
 - 1. Body, stem, ball, handle, end connectors:
 - a. PVC ASTM D1784-12454B.
 - 2. Ball Seat: Teflon.
 - 3. O-rings: EPDM.
- C. Design Requirements:
 - 1. SCHD 80
 - 2. Full port
 - 3. Rated at 150 PSI at 75 DEGF.
 - 4. Double or "true union" design.
 - 5. Blocks both directions, upstream and downstream.
 - 6. Union nut capable of compensating for seat wear.
 - 7. Body with mounting pad for actuators where required.
 - 8. Capable of being disconnected at downstream end under full line pressure.
 - 9. Sodium hypochlorite service:
 - a. Provide "vented" ball valves for all service with greater than 5 PCT concentrated sodium hypochlorite.

2.4 ACCESSORIES

- A. Refer to Drawings and valve schedule for type of actuators.
 - 1. Furnish actuator integral with valve.
- B. Refer to Specification Section 40 05 51 for actuator requirements.

2.5 SOURCE QUALITY CONTROL

- A. Shop test AWWA C507 ball valves in accordance with AWWA C507.
- B. Furnish record of test.
- C. Product Testing: MSS SP-110.

2.6 POLYPROPYLENE (PP) BALL VALVES, CAM LOCK FITTINGS & TANK ADAPTER

- A. Reinforced PP 2" body ball valve with integral female hose thread inlet & male cam lock outlet.
- B. Reinforced PP 2" FPT tank adapter, MPT x female cam lock.
- C. Reinforced PP male 2" cam lock x push-on hose and female cam lock x push on hose fittings.
- D. Parts above shall be compatible with each other and suction hose.
- E. Acceptable maker Banjo Corp.

2.7 SUCTION HOSE

- A. EPDM tube, polyethylene helix, convoluted outer cover, smooth interior.
- B. Bend radius 5" for 2" dia. size, 25 psi at 104 F for 4" dia. size, opaque blue color.
- C. Provide compatible bolted clamps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 40 05 51.

3.2 FIELD QUALITY CONTROL

- A. For AWWA C507 ball valves and in accordance with Specification Section 01 75 00, employ and pay for services of equipment manufacturer's field service representative(s) to:
 - 1. Inspect equipment covered by this Specification Section.
 - 2. Supervise adjustments and installation checks.
 - 3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
 - 4. Conduct startup of equipment and perform operational checks.
 - 5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.

END OF SECTION

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SECTION 40 05 64 BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Butterfly valves.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
 - 4. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
 - 2. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - e. A436, Standard Specification for Austenitic Gray Iron Castings.
 - f. A536, Standard Specification for Ductile Iron Castings.
 - 3. American Water Works Association (AWWA):
 - a. C504, Standard for Rubber-Seated Butterfly Valves.
 - 4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-67, Butterfly Valves.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
 - 3. For valves 8 IN and larger, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Crane
 - 2. Pratt.

3. DeZurik.
4. Clow.
5. Mueller.
6. Bray.
7. ASAHI/America
8. Hayward Industrial
9. Georg Fisher
10. Victaulic
11. Grinnell
12. Nibco
13. Appollo
14. Watts
15. Valmatic/American

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 PVC BUTTERFLY VALVES:

- A. PVC or reinforced PP lever that latches in 19 or more positions.
- B. PVC or reinforced PP body, lugged with 316 stainless inserts to mate to ANSI 150 flanges, suitable for dead end service without downstream flange.
- C. Stem extension of 316 ss and ss or factory epoxy coated carbon steel neck extension where Drawings indicate stem and neck extension.
- D. Stem of 316 ss. PVC or PP disc. EPDM seal.
- E. Rated 150 psi, bidirectional.
- F. Acceptable makes & models include Georg Fisher 578, ASAHI/America 57IL, Hayward BYV (except not in extended applications unless provided with gear).

2.3 HIGH PERFORMANCE BUTTERFLY VALVES:

- A. In locations where reliability is critical, for automated valves that modulate for flow control or actuate periodically in intervals less than 2 HRS, high performance butterfly valves with an offset disc design shall be used.
- B. Design Requirements:
 1. One-piece shaft.
 2. Separate shaft seal.
 3. Minimum shaft diameter to conform to AWWA C504, Class 150B.
- C. Materials of construction:
 1. Disc: 316 stainless steel.
 2. Shaft and pins: 17-4PH stainless steel or 316 stainless steel.
 3. Seals:
 - a. Water: PTFE.
 - b. Process air and high temperature: Graphite rings.
 4. Backing ring: Stainless steel.
 5. Bushings/Bearings: TFE/Glass liner with a 316 Stainless steel shell.
 6. Seat:
 - a. Two part with encapsulated RTFE or PTFE.
 - b. Seat Retainer: Stainless Steel.
 - c. Or Stainless Steel.
 7. End connection: Lugged valves may be used.

2.4 BUTTERFLY VALVES NOT IDENTIFIED AS PVC ON THE DRAWINGS

- A. For use in all locations, except where PVC butterfly valves are required.
- B. Rated 150 psi or better. Non-buried, non-grooved valves shall comply with MSS-SP-67.

- C. Materials:
1. Valve bodies:
 - a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
 - b. Grooved end valves may have factory painted carbon steel flanges.
 2. Valve shafts:
 - a. Stainless steel.
 - b. Pins: stainless steel.
 - c. Bushings/Packing/O-rings: EPDM, RTFE or TFE.
 - d. Bearings: Reinforced TFE or equal.
 3. Valve discs:
 - a. Ductile iron with nickel edge or 304 Stainless Steel disc.
 4. Valve seats:
 - a. Water: EPDM or Hycar.
 5. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.
- D. Design Requirements:
1. Seat type: Resilient.
 2. Body type:
 - a. Lugged when exposed and MJ when buried except where Drawings specifically indicate grooved or specifically indicate lugged or wafer in a buried application.
 - b. Lugged shall have fully tapped anchor lugs drilled per ASME B16.5.
 3. Direct buried valves all meet AWWA 504:
 - a. Buried service gear operator.
 - b. Epoxy coated coated and lined.
 - c. Box, lid, stem extension and wrench similar to what is specified for buried gate valves.

2.5 GENERAL USE BUTTERFLY VALVES

- A. For use in all location, except where high performance butterfly valves are required.
- B. Comply only with AWWA C504, as noted in this Specification Section.
- C. Materials:
1. Valve bodies:
 - a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
 - b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
 2. Valve shafts:
 - a. One-piece stainless steel, Type 304.
 - b. Pins: 304 stainless steel.
 - c. Bushings/Packing/O-rings: EPDM, RTFE or TFE.
 - d. Bearings: Reinforced TFE or equal.
 3. Valve discs:
 - a. Cast iron with welded nickel edge or 304 Stainless Steel disk.
 4. Valve seats:
 - a. Water: EPDM or Hycar.
 - b. Compressed air: Teflon, PTFE.
 - c. Process air: Viton, RTFE, rate for 300 DEGF minimum or higher if required by service.
 5. Shaft bearing: Bronze, TFE-coated stainless steel or reinforced TFE.
 6. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.
- D. Design Requirements:
1. Seat type: Resilient.
 2. Body type:
 - a. Wafer Lug (laying length may vary from AWWA C504).

- b. Equip wafer type with fully tapped anchor lugs drilled per ASME B16.5.
- 3. Direct buried valves:
 - a. All valves: Working pressure rated for 150 PSI (Class 150B per AWWA C504).
- 4. Shaft diameter: One-piece constant diameter.

2.6 ACCESSORIES

- A. Refer to Drawings and/or valve schedule for type of actuators.
 - 1. Furnish actuator integral with valve.
- B. Refer to Section 40 05 51 for actuator requirements.
- C. Valve Flange Seal Rings:
 - 1. If Steel Slip-on flanges are being used on the process piping, flange seals will be required for proper installation of valves.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Section 40 05 51.

END OF SECTION

SECTION 40 05 66

CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Check valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 51 - Valves - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. American Water Works Association (AWWA):
 - a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 IN through 24 IN NPS.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, manufacturers listed under the valve with types are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 SWING CHECK VALVES: 3 IN TO 24 IN

- A. Swing Check Valves (Water, Wastewater, Sludge):
 - 1. Comply with AWWA C508.
 - 2. Acceptable manufacturers:
 - a. Clow.
 - b. American Darling.
 - c. Golden Anderson.
 - 3. Materials:
 - a. Body and cover: Cast iron.
 - b. Seat ring, hinge:

4. Design requirements:
 - a. 175 PSI working pressure (3 to 12 IN).
 - b. 150 PSI working pressure (14 to 24 IN).
 - c. Furnish with outside weight and lever or lever and spring.

2.3 RUBBER FLAPPER SWING CHECK VALVES (FLEX CHECK VALVES): 2 IN TO 24 IN

- A. ASME B16.1, Class 125 (175 PSI).
- B. Acceptable Manufacturer:
 1. APCO Series 100.
- C. Materials:
 1. Body and cover: Cast iron.
 2. Flapper: Buna-N, steel reinforced.

2.4 BALL CHECK VALVES

- A. ASME B16.1, Class 125 (175 PSI).
- B. Acceptable Manufacturer and Models:
 1. Flowmatic Model 408.
 2. Approved Equal
- C. Materials:
 1. Body and cover: Ductile Iron.
 2. Ball: Buna-N-vulcanized coated hollow iron ball.
- D. Connections: 125 or 150 lb. ANSI Flanges.
- E. Design:
 1. Bolted cleanout port.
 2. Sinking Ball.
 3. 150 psi pressure rating.
- F. Coating and Lining: Two Part Epoxy coating (inside and out) suitable for submerged applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 40 05 51.
- B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 40 41 13
HEAT TRACING CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Heat tracing cable as required for heat tracing of pipes as indicated on the Drawings.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data:
 - a. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.
 - b. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.
 - c. Length of heat tape for each pipe size and run.
 - d. Coordinate and verify length and Watts/FT of heat tape required based upon pipe size and insulation thickness.
 - 1) Include the calculations to support the heat tape output.
 - 2) Clearly show assumptions and design criteria utilized in the calculations
 - 3) Follow IEEE Standard 515 calculation protocol.
 - e. See Section 26 05 00 for additional requirements.
 - 3. Fabrication and/or layout drawings:
 - a. Wiring diagrams showing physical locations of thermostats and heat trace power supply.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Test reports: Megger test results.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Shall be stored such that they are not exposed to sunlight or other UV rays.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Chemelex Division; Raychem Corp.
 - 2. Chromalox.
 - 3. Delta-Therm.
 - 4. Thermon.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 HEAT TRACING

- A. Design Parameters:
 - 1. Pipe diameter, length and material: See Drawings and relevant piping Specifications.
 - 2. Flange, valve, pipe support size: See Drawings and relevant piping Specifications.
 - 3. Pipe insulation type and thickness: See Drawings and relevant piping Specifications.
 - 4. Temperatures requirements:
 - a. Low ambient temperature for the specific location: 0 DEGF.
 - b. Start-up temperature:
 - 1) Water lines: 40 DEGF.
 - c. Maintain temperature (power thermostat set point):
 - 1) Water lines: 40 DEGF.
 - d. High temperature exposure with power off: 185 DEGF.
 - 5. Wind factor for the specific location: 30 MPH.
 - 6. Electrical requirements:
 - a. Voltage: 120 V.
 - b. Circuit breaker: Field coordinate if other than 20A GFEPIC type.
 - 7. Safety factor: 10 PCT.
- B. Thermostats adjustable between 35 and 200 DEGF minimum with maximum differential range of 9 DEGF, furnished complete with NEMA 4 enclosures in all areas, stainless steel temperature bulb and capillary.
- C. All necessary or required components and accessories, such as power connection boxes, end seals, straps, tape and fitting brackets.
- D. Self-Regulating Cable:
 - 1. Parallel circuit construction consisting of an inner core of conductive material between parallel copper bus wires.
 - 2. Inverse temperature - conductivity characteristics. The conductive core material increases or decreases its heat output in response to temperature changes.
 - 3. Inner thermoplastic jacket extruded over and bonded to the core material.
 - 4. Outer thermoplastic jacket extruded over the inner jacket.
 - 5. Stranded tinned copper metal overbraid.
 - 6. Overjacket:
 - a. In noncorrosive and nonhazardous locations, insulation shall be Polyolefin.
 - b. In corrosive, hazardous and hydrocarbon locations insulation shall be Fluoropolymer (Teflon).
 - 7. Cable heat output as required by the application.
 - 8. Maximum exposure: 185 Deg F.
 - 9. UL listed.
- E. In noncorrosive and nonhazardous locations, insulation shall be Polyolefin.
- F. In corrosive, hazardous and hydrocarbon locations insulation shall be Fluoropolymer (Teflon).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

- A. Insulate and heat trace wet pipe systems as indicated on Drawings.
- B. Install materials in accordance with manufacturer's instructions.
 - 1. Each circuit shall not exceed the manufacturer's recommended maximum length.
- C. For Metallic Piping:
 - 1. Heat tracing shall be installed completely wired.
 - 2. Cut heat trace to lengths as required and secure to pipe with glass or polyester fiber tape.
- D. For Nonmetallic Piping:
 - 1. Allow for extra heat trace output because nonmetallic pipe has a lower heat transfer.
 - a. Heat tracing shall be installed completely wired.
 - 2. Cut heat trace to lengths as required and secure to pipe with aluminum tape throughout the length of the trace.
- E. Protection and Control Requirements:
 - 1. Protection by a GFEPIC circuit breaker.
 - a. Breaker amperage rating shall be coordinated with Contractor when different than the Contract Drawings.

3.3 TESTING

- A. Megger the cables at the manufacturers recommended voltage level three times.
 - 1. Before installation.
 - 2. After attachment to pipe but before insulation is installed.
 - 3. After pipe insulation is installed but before energization.

END OF SECTION

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SECTION 40 42 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation:
 - a. Piping insulation.
 - b. Duct insulation.
 - c. Equipment insulation.
 - 2. Adhesives, mastics, sealants, and finishes.
 - 3. Grease and air ventilation duct wrap fire protection systems.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
 - b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - d. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - e. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - f. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - h. E96, Standard Test Methods for Water Vapor Transmission of Materials.
 - i. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
 - j. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - l. E119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
 - m. E136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
 - n. E162, Surface Flammability of Materials.
 - o. E814, Through-Penetration, 2-Hour Firestop Test.
 - p. E2336: Standard Test Methods Fire Resistive Grease Duct Enclosure Systems.
 - 2. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
 - 3. National Fire Protection Association (NFPA):
 - a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

5. National Commercial and Industrial Insulation Standards (2013 seventh edition).
 - a. Published by Midwest Insulation Contractors Association (MICA).
 - b. Endorsed by National Insulation Association (NIA).
 - c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.
 3. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
 4. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Elastomeric insulation:
 - a. Rubatex.
 - b. Armstrong.
 2. Fiberglass insulation:
 - a. CertainTeed Corporation.
 - b. Johns Manville.
 - c. Owens Corning.
 - d. Knauf.
 3. PVC jacket:
 - a. Ceel-Co.
 - b. PIC Plastics.
 4. Equipment insulation:
 - a. CertainTeed Corporation.
 - b. Johns Manville.
 - c. Owens Corning.
 5. Ductwork insulation:
 - a. CertainTeed.
 - b. Johns Manville.
 - c. Owens Corning.
 6. High density perlite:
 - a. Johns Manville.
 - b. Industrial Insulation Group (LIC).
 7. High density calcium silicate:
 - a. Industrial Insulation Group (LIC).
 8. Adhesives, mastics, sealants, and finishes:
 - a. Foster Products.
 - b. Childers.
 - c. Dow Corning.
 - d. Johns Manville.
 - e. Knauf.

- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 PIPING INSULATION - ELASTOMERIC

A. General:

1. Insulation fire and smoke hazard ratings for composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation), as tested by procedure ASTM E84, NFPA 255 and UL 723, not exceeding:
 - a. Flame spread: 25.
 - b. Smoke developed: 50.
2. Accessories (adhesives, mastics, cements, and tapes: Same component ratings as listed above.
3. Indicate on product labels or their shipping cartons: Flame and smoke ratings do not exceed above requirements.
4. Permanent treatment of jackets or facings to impart flame and smoke safety is required.
 - a. Water-soluble treatments are prohibited.
5. Insulated shields at pipe support points.

B. Pipe, Fitting, and Valve Insulation:

1. Flexible elastomeric closed cell pipe insulation.
 - a. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT²-DEGF) at mean temperature of 75 DEGF, temperature range -40 to 220 DEGF; permeability not to exceed 0.20 by ASTM E96; water absorption 3 PCT by ASTM D1056 and ozone resistance.
2. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:

1. Preformed fiberglass pipe insulation:
 - a. Density: 4 LBS/CUFT.
 - b. Temperature rated: 650 DEGF.
 - c. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT²-DEGF) at mean temperature of 75 DEGF.
 - d. Fire hazard rating:
 - 1) UL 723, ASTM E84, NFPA 255.
 - 2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
2. Moisture adsorption:
 - a. ASTM C553.
 - b. Not greater than 5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.
3. Fungi and bacteria resistance:
 - a. ASTM C665.
 - b. Does not breed or promote growth.
 - c. Flame attenuated glass fibers bonded with thermosetting resin.
4. Piping jackets (general applications):
 - a. Aluminum: 16 MIL embossed aluminum.
 - b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
 - c. Piping jacket not required on concealed piping.
5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.4 PIPE INSULATION INSERTS AT HANGERS

A. High Density Perlite:

1. Pre-formed.

2. Fire hazard rating:
 - a. UL 723, ASTM E84, NFPA 255.
 - b. Flame spread: Zero.
 - c. Smoke developed: Zero.
 3. Average density: 13 LBS/CUFT.
 4. Compressive strength: 80 PSI to produce 5 PCT compression.
 5. Maximum surface temperature: 1,200 DEGF.
- B. High Density Calcium Silicate:
1. Pre-formed.
 2. Fire hazard rating:
 - a. UL 723, ASTM E84, NFPA 255.
 - b. Flame spread: Zero.
 - c. Smoke developed: Zero.
 3. Average density: 14 LBS/CUFT.
 4. Compressive strength: 100 PSI to produce 5 PCT compression.
 5. Maximum surface temperature: 1,200 DEGF.

2.5 EQUIPMENT INSULATION

- A. Insulation for Equipment:
1. Fire hazard classification:
 - a. UL 723, ASTM E84, NFPA 255.
 - b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
 2. Provide minimum insulation thickness conforming to Schedules, or as shown on Drawings.

2.6 DUCTWORK INSULATION: FIBERGLASS

- A. Flexible Insulation:
1. Material: Commercial-grade fiberglass thermal insulation, formaldehyde free.
 2. Scheduled thickness and installed R-value. Installed R-value when compressed to a maximum of 25 PCT following recommended duct wrap stretch outs.
 3. Factory-applied foil scrim vapor barrier facing.
 4. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT²-DEGF) at a mean temperature of 75 DEGF (installed).
 5. Fungi and bacteria resistance:
 - a. ASTM C1338.
 - b. Does not breed or promote growth.
 6. Fire hazard classification:
 - a. UL 723, ASTM E84, NFPA 255.
 - b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
 7. Basis of design: Johns Manville Microlite fiberglass duct wrap insulation.
- B. Semi-Rigid Insulation for Indoor Installation:
1. Scheduled thickness and R-value.
 2. Factory applied vapor barrier facing-white scrim foil.
 3. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT²-DEGF) at a mean temperature of 75 DEGF.
 4. Fungi and bacteria resistance:
 - a. ASTM C1338.
 - b. Does not breed or promote growth.
 5. Moisture adsorption:
 - a. ASTM C553.
 - b. Not greater than 0.5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.
- C. Semi-Rigid Insulation for Outdoor Installation:
1. Scheduled thickness and R-value.
 2. Factory-applied foil scrim vapor barrier facing.

3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT²-DegF) at mean temperature of 75 DEGF.
4. Minimum density: 3 LBS/CUFT.
5. Fungi and bacteria resistance:
 - a. ASTM C1338.
 - b. Does not breed or promote growth.
6. Basis of Design: Johns Manville #815 SPIN-GLASS fiberglass duct insulation.

2.7 INSULATION FOR 2" COMBINATION AIR VALVE

- A. Either of the following.
 1. Fit Tight Covers:
 - a. Jacket: 17oz silicone impregnated fiberglass fabric
 - b. Liner: 17oz silicone impregnated fiberglass fabric
 - c. Insulation: 1" Type E glass mat
 - d. Fastening: 2" wide hook & loop tape or 1" Straps and Stainless Steel D-Rings or 3/16" braided Kevlar drawstrings or 12ga stainless steel lace hooks and quilt pins.
 - e. Thread: Kevlar/Stainless Steel Thread
 2. ThermaXX LLC
 - a. Insulation: Glass mat, type E needled fiber ¼", ½" @ 9 LB/CF & 1" @ 11.3 LB/CF.
 - b. Jacket: PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
 - c. Liner: PTFE Fiberglass Composite Jacketing, 16.5 oz/sq. yd. minimum
 - d. Thread: Diameter- .0114, Break Point – 35LBS
 - e. Construction: Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching using thread in section 1.3D. The thread must be able to withstand the skin temperatures without degradation. Hog rings, staples and wire are not acceptable methods of closure. No raw cut jacket edges shall be exposed. Jackets shall be fastened using hook and loop straps and 1" Slide Buckles. All stitching will be done with specified thread.
 - f. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.
 - g. All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric and shall be secured using hook & loop closure parallel to the seam.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. General:
 1. Piping below ground covered with earth will not be insulated.
 2. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
 3. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
 - a. Consider ductwork, piping and equipment above ceilings as concealed.
 4. Provide release for insulation application after installation and testing is complete.
 - a. Apply insulation on clean, dry surfaces after inspection.
 5. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
 6. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
 - a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
 - b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.

7. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.
- C. Piping Insulation - Elastomeric:
1. Do not insulate until satisfactory completion of required pressure testing.
 2. Apply insulation to clean, dry surfaces.
 3. Slip insulation on pipe prior to connection.
 - a. Whenever the slip-on technique is not possible provide insulation neatly slit and snapped over the pipe.
 4. Fabricate and install fitting cover insulation according to manufacturer's recommendations.
 5. Seal joints, slits, miter-cuts and other exposed edges of insulation with adhesive, recommended by the insulation manufacturer, to ensure complete vapor barrier.
- D. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
 - a. Butt all joints together firmly.
 2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
 3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
 4. PVC pipe jacket:
 - a. Apply jacketing with a minimum of 1 IN overlap.
 - 1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
 - b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
 - 1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
 - c. Provide pre-molded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
 5. Aluminum pipe jacket:
 - a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
 - b. Provide smooth and straight joint with a minimum 2 IN overlap.
 - c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
 - d. Center spacing of screws 5 IN maximum or as required to provide smooth tight-fitted joints.
 - e. Place joints on least exposed side of piping to obtain neat appearance.
- E. Equipment: Install per manufacturer's instructions.
- F. Ductwork Insulation - Fiberglass:
1. Flexible insulation:
 - a. Butt edges tightly.
 - 1) Secure insulation with Benjamin Foster 85-20 adhesive applied in 6 IN strips on 12 IN centers and/or pins, applied on not more than 18 IN centers so that the insulation conforms to the duct surfaces uniformly and firmly.
 - b. Seal joints with facing overlap or 4 IN wide strips of like facing material adhered and stapled in place.
 - c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20.
 - d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.
 2. Semi-rigid insulation:
 - a. Impaling over pins.
 - 1) Apply insulation with edges tightly butted.
 - 2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
 - 3) Clip pins off close to clip.
 - 4) Space pins as required to hold insulation firmly against duct surface but not less than one pin per 1.5 SQFT.

- 5) Seal joints and speed clips with 3 IN wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
- b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
 - 1) Cover the entire surface of duct with adhesive.
 - 2) Use corner metal angle to protect edge of insulation.
 - 3) Protect edge of insulation.
 - 4) Seal joints as above.
- c. For outdoor application finish with Benjamin Foster #4610 weatherproof mastic with white glass fabric membrane.

3.2 REPAIR

- A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

- A. Refrigeration Lines (35-60 DEGF):
 1. Elastomeric.
 2. 1/2 IN thickness for lines 1 IN and smaller.
- B. Pipe, Fittings and Valves:
 1. Elastomeric: 2" thick on Chilled Water Piping.
 2. Fiberglass.

APPLICATION	PIPE SIZE	THICKNESS	JACKET
Hot Water (domestic)	1-1/2 IN and less	1 IN	PVC
	Over 1-1/2 IN	1-1/2 IN	PVC
Cold Water (domestic)	All sizes	1 IN	PVC
Condensate Drain and Refrigeration Lines (35 - 60 DEGF)	All	1 IN	PVC inside building. Aluminum outside building

- C. Equipment:

EQUIPMENT	INSULATION SYSTEM
Hot water pumps	Uninsulated
Below drain pans serving cooling coils, pre-heat systems, domestic water heaters	1 IN flexible elastomeric closed cell sheet.
Cold water meter	Uninsulated
Chilled Water Buffer Tank	2 IN elastomeric

- D. Ductwork:
 1. Fiberglass.

DUCT SERVICE	INSULATION AND THICKNESS	MINIMUM R-VALUE (HR-FT ² -DEGF)/BTU
Outside air and supply air downstream of heat recovery units, outside building	2-1/2 IN semi-rigid for outdoor installation	12.0

DUCT SERVICE	INSULATION AND THICKNESS	MINIMUM R-VALUE (HR-FT ² -DEGF)/BTU
Outside air ducts, inside building	2-1/2 IN semi-rigid with vapor barrier	12.0
Supply and return air ducts inside building	2 IN flexible with vapor barrier	6.0
Supply and return air ducts outside building and where exposed to atmospheric air	2-1/2 IN semi-rigid for outdoor installation	12.0
Return air duct in non-conditioned areas including shafts	2-1/2 IN flexible with vapor barrier	12.0
Exhaust air ducts upstream of heat recovery units, inside building	1-1/2 IN semi-rigid	6.0
Exhaust air ducts upstream of heat recovery units, outside building	2-1/2 IN semi-rigid for outdoor installation	12.0
All other ductwork	Uninsulated	N/A

END OF SECTION

SECTION 40 60 05
WATER CONTROL GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water control gates.
 - 2. Canal gates.
 - 3. Slide (fabricated) gates.
 - 4. Flap gates or valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A126, Gray Iron Castings for Valves Flanges, and Pipe Fittings.
 - 2. American Water Works Association (AWWA):
 - a. C560, Standard for Cast-Iron Slide Gates.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgment that products submitted meet the requirements of standards referenced.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Water control gates:
 - a. Rodney Hunt.
 - b. Waterman Gates
 - c. Golden Harvest Gates
- B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 CANAL GATES

- A. Materials:
 - 1. Seating faces: Cast Iron, ASTM A126, Class B
 - 2. Rails and Yoke: Structural Steel, ASTM A36
 - 3. Stems: Stainless Steel, Type 304
 - 4. Lift Nut: Bronze, ASTM B584, Alloy 844 or 865
 - 5. Assembly Hardware: Stainless Steel
 - 6. Two Part Epoxy coating
- B. Fabrication:
 - 1. Frame and Cover:
 - a. All parts of the gate shall have a minimum material thickness of 1/4th inch.
 - b. Cast Iron covers shall have machined faces with 0.004 in or less clearance when closed.
 - c. Adjustable cast iron wedges shall be used for sealing.
 - d. Lifting Assemblies:
 - 1) Stem and Couplings:
 - a) The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lbs effort on the crank or handwheel.
 - b) The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have Acme type cold rolled threads with a maximum surface of 16 micro-inches.
 - c) Stems in more than one piece shall be joined together by solid couplings.
 - d) Stems and operators shall be provided with acme threads.

2.1 SLIDE GATES, WEIR GATES, AND STOP GATES

- A. Material:
 - 1. Slide, Spigot, Frame, Stiffeners, Yoke, Guide Angles: Stainless Steel Type 304L
 - 2. Side, Invert, and Top Seals: Neoprene ASTM D-2000 or EDPM
 - 3. Bottom Seal: Neoprene ASTM D-2000
 - 4. Bearing Bars, Guides, Stem guide Liner: UHMW Polyethylene ASTM D4020
 - 5. Threaded Stem and Guides: Stainless Steel ASTM A-276, Type 304
 - 6. Fasteners: Stainless Steel Type 304L
 - 7. Pedestal: Cast Iron ASTM A126
 - 8. Stem Cover: Polycarbonate ASTM A-707
 - 9. Lift Nut and Stop Nut: Manganese Bronze ASTM B584, UNS-C86500
- B. Performance:
 - 1. Leakage shall not exceed the following standards:
 - a. Seating condition: 0.1 gallons per minute per foot of seating perimeter.
 - b. Unseating condition: 0.1 gallons per minute per foot of seating perimeter.
- C. Fabrication:
 - 1. Frame and guides:
 - a. Rigid, welded gate frame and guides: Composed of the guide rails, cross bars, and headrails, with a clear opening the same size as the waterway, unless otherwise specified.
 - b. Construct guides incorporating a dual slot design.
 - 1) The primary slot will accept the plate of the slide (disc).
 - 2) The secondary slot will be sufficiently wide to accept the reinforcing ribs of the disc.
 - c. Design guides for maximum rigidity: Weight not less than 3 LBS per foot.
 - d. Guides of sufficient length to support two-thirds the height of the slide, when the gate is fully open.
 - e. Provide guides of sufficient strength so that no further reinforcing will be required.

- f. Design yoke to support the operating device formed by members welded or bolted at the top of the guides.
 - g. Design yoke arrangement such that the disc and stem can be removed without disconnecting yoke.
 - h. Design yoke to support the lift forces when subjected to a load of 80 LB pull on the operator.
 - i. Design gates with J-seals at the side attached to frame.
 - j. For embedded type gates provide molded resilient seat mounted at bottom of disc for flush bottom closure and seal against embedded portion of the frame in the channel invert or have a resilient seat mounted on frame flush at channel invert.
 - k. Design weir gates or downward opening gates with J-seal attached to bottom frame.
 - l. Design bottom frame member as a minimum of 3 IN of material bearing against slide for weir or downward opening gates.
 - m. Utilize J-seals and resilient seats of synthetic rubber conforming to AWWA C560.
2. Slide (disc):
- a. Plate reinforced slide with structural shapes welded to the plate.
 - b. Sluice Gate, slide cover maximum deflection: $1/720$ of the span of the gate under maximum head.
 - c. Slide Gate, slide cover maximum deflection: $1/360$ of the span of the gate under maximum head.
 - d. Extend reinforcing ribs to guides so that the seating surface of the guide is reinforced.
 - e. Stem connection of either clevis type, with structural members welded to slide and a bolt to act as pivot pin, or a threaded and bolted (or keyed) thrust nut supported in welded nut pocket.
 - f. Pocket and yoke of gate capable of taking at least twice the rated thrust output of the operator at 40 LBS pull. Slide material same as frame and guides.
3. Stem:
- a. Of suitable length and ample strength for the intended service.
 - b. Stem diameter capable of withstanding twice the rated output of the operator at 40 LB pull, and supported such that L/r ratio for unsupported part of the stem shall not exceed 200.

2.2 FLAP GATES OR VALVES

- A. General: Provide flap gates with flange frame for mounting on pipe flange or concrete. Provide lubrication fitting for all hinges.
- B. Materials:
- 1. Frame and cover or flap: Cast-iron, ASTM A126-B.
 - 2. Seats: Resilient-synthetic rubber meeting AWWA C560
 - 3. Hinge arms: High strength malleable iron or high tensile bronze.
 - 4. Hinge pins and anchor bolts: Stainless steel, Type 304.

2.3 SHEAR GATE

- A. Shear gates shall be designed to effectively control flows under seating head conditions. Frame is to be cast aluminum and of flatback type, drilled for mounting to a wall. The seating surface shall be machined aluminum.
- B. The cover shall be cast aluminum with machined aluminum seat and mounted to the frame utilizing a stainless steel hinge bolt. A cast aluminum lifting lug shall be bolted to the cover in such a manner as to allow a swiveling action. The lug shall accept a pipe type lifting rod which is to be field cut to the desired length.

2.4 GATE OPERATORS AND LIFTS

- A. General:
- 1. Provide lifts in accordance with AWWA C560 or as modified in this Specification Section.
 - 2. Provide all lifts with clear butyrate plastic stem cover with Mylar open-close indicator.

- B. Manual Operators:
 - 1. Centerline of crank or handwheel approximately 36 IN above operating floor, unless otherwise shown.
 - 2. Maximum effort of 40 LBS on crank or handwheel shall operate gate after unseating gate from wedges bored upon seating head specified.

2.5 ALL GATES, VALVES, OPERATORS AND LIFTS

- A. Comply to requirements of Specification Section 40 05 51.
- B. Provide gates, including lift, designed with a minimum factor of safety of five.
 - 1. Provide rising stems on all gates.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Installation Check and Start-up:
 - 1. Employ and pay for services of the equipment manufacturer's field service representative(s) fully commissioned and authorized by manufacturers to do the following:
 - a. Inspect equipment covered by this Specification Section.
 - b. Supervise adjustments, calibrations and installation checks and full commissioning.
 - c. Provide Owner with a written statement that manufacturer's equipment has been installed properly, lubricated, and calibrated and is ready for operation by the Owner.
- B. Field Leakage Test for Sluice Gate:
 - 1. Test gate under design seating head and adjust to maximum leakage of 0.1 gpm per foot of seating perimeter.

END OF SECTION

SECTION 40 61 13
PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for complete instrumentation system for process control.
 - 2. Requirement for Contractor to subcontract the Process Control System portion of the Work to a "Systems Integrator".
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.
 - 4. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. The International Society of Automation (ISA):
 - a. 7.0.01, Quality Standard for Instrument Air.
 - b. S5.1, Instrumentation Symbols and Identification.
 - c. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 3. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
 - 5. National Institute of Standards and Technology (NIST)
 - a. SP 800-82, Guide to Industrial Control Systems (ICS) Security
- B. Qualifications:
 - 1. System Integrator:
 - a. Experience:
 - 1) Have satisfactorily provided control system integration for a minimum of five projects of similar magnitude and function.
 - b. Certification:
 - 1) Control Systems Integrators Association (CSIA) Certification
 - c. Qualification:
 - 1) Regularly engaged in the design and the installation of process control and instrumentation systems and their associated subsystems as they are applied to the fish aquaculture industry.
 - 2) Maintains a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, documenting, fabricating, installing, calibrating, programming, configuring, providing training services, and testing the systems specified herein.
 - 3) Capable of responding to on-site problems within 24 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.
- C. Miscellaneous:
 - 1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.3 DEFINITIONS

- A. Calibrate: To standardize a device so that it provides a specified response to known inputs.
- B. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.
- C. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
- D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.
- E. System Integrator: A Contractor/Subcontractor who combines instrumentation, control devices, hardware, software, and networking products from multiple vendors to provide a fully functioning control system.

1.4 SYSTEM DESCRIPTION

- A. Control System Requirements:
 - 1. This Specification Section provides the general requirements for the control system.
 - 2. The control system consists of all primary elements, transmitters, switches, controllers, computers, communication devices, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.
 - 3. Environmental Suitability: Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.
- B. Utilization of System Integrator:
 - 1. Retain a System Integrator subcontractor to provide a fully functioning control system.
 - a. The System Integrator shall be responsible for the provision of an integrated control system fully functioning in accordance with the requirements of the Contract Documents.
 - 2. Provide all required coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

1.5 SUMMARY OF WORK

- A. Primary Elements and Transmitters:
 - 1. Furnish and install new instrumentation as specified in Sections 40 71 00, 40 72 00, 40 73 00, 40 75 00, and as shown on the Contract Documents.
 - a. Provide calibration and testing to verify the equipment is ready for operation.

- B. Local Control Panels:
1. Furnish and install new local control panels as specified in Section 40 67 00 and as shown on the Drawings:
 - a. Control auxiliary equipment for the control panels shall meet the requirements of specification Section 40 78 00.
 - b. Uninterruptible power supplies for the control panels shall meet the requirements of specification Section 40 67 63.
 - c. Surge protection devices for the control panels shall meet the requirement of specification Section 40 61 43.

1.6 SUBMITTALS

- A. Shop Drawings:
1. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
 - a. Facsimile information is not acceptable.
 2. Limit the scope of each submittal to one Specification Section.
 - a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
 - b. Do not provide any submittals for Specification Section 40 61 13.
 3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Equipment catalog cut sheets.
 - c. Instrument data sheets:
 - 1) ISA S20 or approved equal.
 - 2) Separate data sheet for each instrument type.
 - d. Materials of construction.
 - e. Minimum and maximum flow ranges.
 - f. Pressure loss curves.
 - g. Physical limits of components including temperature and pressure limits.
 - h. Size and weight.
 - i. Electrical power requirements and wiring diagrams.
 - j. NEMA rating of housings.
 - k. Submittals shall be marked with arrows to show exact features to be provided.
 4. Comprehensive asset inventory of all networked components:
 - a. Provide in Excel spreadsheet format.
 - b. Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in asset inventory.
 - c. Include:
 - 1) Device ID.
 - 2) Manufacturer.
 - 3) Model Number.
 - 4) Serial Number.
 - 5) Device Use description.
 - 6) Firmware.
 5. Comprehensive set of wiring diagrams as specified in Section 40 67 00.
 6. Panel fabrication drawings as specified in Section 40 67 00.
 7. Nameplate layout drawings.
 8. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
 - a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
 9. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
 - a. Furnish electronic files on owner's designated electronic media.
 - b. Drawings in AUTO CAD format on a portable flash drive.

10. Provide a parameter setting summary sheet for each field configurable device.
 11. Certifications:
 - a. Documentation verifying that calibration equipment is certified with NIST traceability.
 - b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
 - 1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
 12. Testing reports: Source quality control reports.
- B. Qualifications Submittal:
1. Documentation verifying contractor/subcontractor adherence to specified certifications and qualifications
- C. Contract Closeout Information:
1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 2. All Shop Drawings shall be modified with as-built information/corrections.
 3. Instrumentation and Control Equipment Operation and Maintenance Manual Content:
 - a. Provide a printed copy of the following sheets following the Equipment Record sheets or ISA Data Sheets.
 - 1) Loop Check-out Sheet.
 - 2) Instrument Certification Sheet.
 - 3) Final Control Element Certification Sheet.
 - b. Provide the following detailed information:
 - 1) Use equipment tag numbers from the Contract Documents to identify equipment and system components.
 - 2) As-constructed fabrication or layout drawings and wiring diagrams.
 - c. Additional information as required in the associated equipment or system Specification Section.
 4. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Specification Section 01 65 50.
- B. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

- A. Provide enclosures/housing for control system components in accordance with the area designations provided on the Drawings.
 1. Areas designated as wet: NEMA Type 4.
 2. Areas designated as wet and/or corrosive: NEMA Type 4X.
 3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
 - a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
 - 1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
 4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
 - a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
 - 1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.

5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Unless stated otherwise, system operating criteria are as follows:
 1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5% full travel.
 2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
 3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3% of full scale over a 6:1 operating range.
 4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5% of full travel regardless of force required to position final element.
 5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0% of full scale.
 6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

- A. Provide identification devices for instrumentation system components in accordance with Specification Section 10 14 00.
- B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.
- B. Install electrical components per the requirements of the Electrical design.

3.2 FIELD QUALITY CONTROL

- A. See Section 01 75 00 and Section 40 61 21.

END OF SECTION



Loop Check-out Sheet

Project Name:	Owner's Project No. (if applicable):	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK ₍₁₎			TERM/CONT CHECK ₍₂₎		TERM/CONT CHECK ₍₂₎	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.

2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

FINAL CONFIGURED SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: _____
(Work Performed By)

Date: _____



Instrument Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

% OF SPAN	INCREASING INPUT			DECREASING INPUT		
	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

ACTUATION POINT	INCREASING INPUT			DECREASING INPUT		
	INPUT	OUTPUT	ERROR (% of range)	INPUT	OUTPUT	ERROR (% of range)
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____

Date Certified: _____



Final Control Element Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Tag No.	Actuator: Pneumatic: _____ Electric: _____
Description:	Positioner: Direct: _____ Reverse: _____
Manufacturer:	Positioner: Input: _____ Output: _____
Model No.	I/P Converter: Input: _____ Output: _____
Serial No.	Valve to _____ on air failure
	Valve to _____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%						
25%						
50%						
75%						
100%						

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____

Date Certified: _____

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SECTION 40 61 21
PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements for testing of the Process Control System (PCS) hardware and software prior to shipment to the site for installation.
 - a. Inspection.
 - 1) System hardware operational testing.
 - b. Test records.
 - 2. Requirements for field testing of the PCS hardware and software.
 - a. Process Control System checkout.
 - b. Instrument calibration.
 - c. Loop testing/checkout.
 - d. Integrated Site Acceptance Test (SAT).
 - e. Operational Readiness Demonstration (ORD).
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control System General Requirements.
 - 4. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 SUBMITTALS

- A. See Specification Section 40 61 13 - Process Control System General Requirements.
- B. Submit factory acceptance test (FAT) procedures not less than 15 calendar days prior to the scheduled start of the FAT. Include the following:
 - 1. Modular test plans and procedures to allow individual test segments to be repeated if necessary.
 - 2. Description of individual test segments and steps comprising each segment, particularly the methods and processes to be followed.
 - 3. Procedures for monitoring, correcting, and retesting variances.
 - 4. Procedures for controlling and documenting all changes made to the hardware/software after the start of testing.
 - 5. Descriptions of test equipment.
 - 6. Expected results for each segment, including pass/fail criteria.
 - 7. Documentation record forms to be used to certify results of factory testing.
- C. Post factory acceptance test:
 - 1. Final documentation certifying that all Factory tests have passed with satisfactory results.
- D. Field Testing Shop Drawings:
 - 1. Site Acceptance Test (SAT) Plan.
 - a. Divide into separate sections based on process systems.
 - b. Each section shall include a sequential step-by-step checkout plan.
 - 2. Typical Loop Checkout Sheets, if other than the form included within contract documents.
 - 3. Typical Instrument Certification Sheets, if other than the form included within contract documents.
 - 4. Typical Final Control Element Certification Sheets, if other than the form included within contract documents.

- E. Contract Closeout Information:
 - 1. Site Acceptance Test (SAT) Report.
 - 2. Completed Loop Checkout Sheets.
 - 3. Completed Instrument Certification Sheets.
 - 4. Completed Final Control Element Certification Sheets.
 - 5. All system startup and checkout records, test records, recommendations and information furnished by Manufacturer's representatives during testing and startup, and amended documentation specified herein.

PART 2 - PRODUCTS

2.1 FACTORY ACCEPTANCE TESTING (FAT) GENERAL:

- A. Testing Documentation
 - 1. Make following documentation available at test site during the tests:
 - a. Contract Documents.
 - b. Factory Demonstration Testing procedures.
 - c. List of equipment to be testing including make, model, and serial number.
 - d. Shop Drawing submittal data for equipment being tested.
 - 2. Engineer reserves the right to review all documentation at any time during testing.

2.2 FAT INSPECTION

- A. Inspect all panels, operator interface terminals and cabinets prior to conducting the FAT to verify quality of workmanship and conformance to the Contract Documents and approved Shop Drawings. Completed inspection forms shall be available for review at time of FAT. Inspection shall include, but not be limited to, the following:
 - 1. Nameplates, warning labels, and tags including correct spelling, color and size of labeling and characters and methods of attachment.
 - 2. Enclosure surfaces flatness, finish, and color.
 - 3. Proper operation of doors, catches, and locks.
 - 4. Wire and cable type, sizes, tagging, color coding and tag placement in readily viewable position/orientation.
 - 5. Wiring runs across hinges properly installed.
 - 6. Proper wiring routing, layout, practices, and grounding.
 - 7. All electrical circuits checked for continuity.
 - 8. Terminal block contact ratings and numbers.
 - 9. Fuses and circuit breakers are correct size and type.
 - 10. Terminal block, fuse, breaker, and other required installed spares.
 - 11. General arrangement and space allocation, including spare usable space in panel and on panel door.
 - 12. Proper placement, isolation, and labeling of intrinsic safety devices and associated wiring.
 - 13. Equipment and devices are properly installed and secured to subpanels and doors using appropriate methods and in appropriate orientation.
 - 14. Fans, blowers, heaters, air-conditioning units, and other environmental controls are operational, unobstructed, and installed with sufficient clearances recommended by component manufacturers.

2.3 FAT - SYSTEM HARDWARE OPERATIONAL TESTING

- A. Packaged systems not present at FAT shall be simulated; communications interfaces shall be simulated to/from vendor confirmed interface registers.
- B. All system hardware components and equipment shall be tested to verify proper operation as standalone units. Tests shall include, but not be limited to, the following:
 - 1. AC/DC power checks.
 - 2. Power fail/restart tests.
 - 3. Verification of UPS power to required components.

4. Diagnostics checks.
5. Verification that all equipment is functioning properly.
6. All electrical circuits energized simultaneously and continuously for 48 HRS without failures.
7. All alarm circuits connected to simulated alarm contacts to verify operation.
8. All interlock and shutdown circuits checked for operability and proper function by means of simulated contact.
9. All hardwired input/output devices and components shall be tested to verify operability and basic calibration.
10. Simulate operation of electronic control and receiving instruments and circuits.
11. Any other test required to place the PCS equipment in an operating state.
12. Compliance with Contract Documents.

2.4 FAT TEST RECORDS:

- A. Maintain records of all factory test results. As a minimum, include the following items:
 1. Name of test procedure.
 2. Date of the test.
 3. Test results for each test segment including a passed/failed indication.
 4. Signatures of individual(s) performing the test and witnesses thereof.

PART 3 - EXECUTION

3.1 GENERAL

- A. Maintain accurate daily log of all testing activities, calibration functions, and final set point adjustments.
- B. All testing may be witnessed by the Owner or Engineer.

3.2 INSTALLATION AND CHECKOUT

- A. Provide the following (after successful completion of the Factory Acceptance Test):
 1. Check and approve the installation of all Process Control System (PCS) components (including but not limited to control panels, field instruments, and all cable and wiring interconnects between various equipment, panels and devices) prior to placing the various processes and equipment into operation. As a minimum, include:
 - a. Verification and documentation that all field instrument signals function properly and are properly calibrated.
 - b. Testing of all final control actions.
- B. Provide services of authorized manufacturer's representatives to check and verify the correctness of the installation and operation of equipment.

3.3 PRE-DEMONSTRATION PERIOD TESTING

- A. Instrumentation Calibration:
 1. Verify and document that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
 2. Factory furnished calibration certifications are acceptable for the following:
 - a. Flow meters.
 - b. Pressure sensors utilized with annular sleeve.
 - c. Temperature sensors.
 3. On-site calibration verification is required for all other instruments, including "smart" transmitters that have been factory calibrated.
 - a. Provide calibration checks at 0 %, 25 %, 50 %, 75 % and 100 % of span for pressure transmitters and gages.
 - 1) Check for both increasing and decreasing input signals to detect hysteresis.
 - b. In addition to factory calibration certification, temperature sensors and gages shall be checked at a single point for conformance to required accuracy.

- c. Level transducers/transmitters shall be checked at two points in addition to zero.
 - d. Analytical sensors shall be calibrated in accordance with manufacturer's recommendations.
 - e. Check operation of all switches to verify actuation occurs in accordance with manufacturer's specified accuracy.
 - f. Replace any instrument which cannot be properly adjusted.
 - 4. Mark range, date, set point and calibrator's initials on each instrument by means of blue or black ink on a waterproof tag affixed to the instrument.
 - 5. Calibration equipment shall be certified by an independent agency with traceability to NIST.
 - a. Certification shall be up-to-date.
 - b. Use of equipment with expired certifications shall not be permitted.
 - 6. Calibration equipment shall be at least three times more accurate as the device being calibrated.
- B. Loop Testing:
- 1. Utilize the Loop Check-Out Sheet located at the end of Section 40 61 13 (or Engineer approved equivalent) to document on-site calibration checks.
 - a. Utilize separate loop checkout form for each loop.
 - 2. Minimum loop checkout requirements:
 - a. Use actual signals where available.
 - b. Check control signal generation, transmission, reception and response for all inputs and outputs for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
 - c. Closely observe controllers, indicators, transmitters, HMI displays, OIT displays, recorders, alarm and trip units, remote set points, ratio systems, and other components.
 - 1) Verify that readings at all loop components are in agreement.
 - 2) Make corrections as required.
 - 3) Following any corrections, retest the loop.
 - d. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
 - e. Check all interlocks for proper functionality.
 - f. Record all set point and calibration changes on all affected Contract Documents and turn over to Owner.
- C. Integrated Site Acceptance Test (SAT):
- 1. Following the testing of each individual loop, perform an integrated Site Acceptance Test (SAT) to verify that all equipment and programmed software are operating as described in the Contract Documents and equipment manufacturers recommendations. Checks to include:
 - a. The intended monitoring and control functions of the PCS including all vendor-furnished equipment packaged systems, communications, operator interfaces, statuses, alarms, trends and recording of historical tags.
 - b. Integrated testing on a system by system basis as described in the submitted Site Acceptance Test (SAT) plan sequential step-by-step checkout plan.
 - 1) Documentation with initials of the individuals who perform each test.
 - 2. Provide minimum fifteen (15) day notice to the Owner prior to commencing the SAT.
 - 3. Promptly address and re-test any malfunctions, issues and incompletions arising during the SAT.
- D. At the successful conclusion of all testing specified in this article, submit the "Instrumentation Supplier's Instrumentation Installation Certificate" required in Section 01 75 00 - Checkout and Start-up Procedures.

3.4 DEMONSTRATION PERIOD

- A. Demonstrate the functional integrity of the Process Control System for the entire facility in accordance with the demonstration period requirements in Section 01 75 00 - Checkout and Start-up Procedures as evidence of Substantial Completion.

END OF SECTION

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SECTION 40 61 43
SURGE PROTECTION DEVICES FOR INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category IC1 SPD - Dedicated 120 VAC circuit, series connection, control panel mounted.
 - 2. Category IC3 SPD - Discrete 120 VAC control signal, control panel mounted.
 - 3. Category IC4 SPD - Analog instrumentation signal, field mounted.
 - 4. Category IC5 SPD - Analog instrumentation signal, control panel mounted.
 - 5. Category IC6 SPD - Combination 120 VAC circuit and analog signal, field mounted.
 - 6. Category IC8 SPD - Data line, control panel mounted.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
 - b. 1283, Standard for Electromagnetic Interference Filters.
 - c. 1363, Standard for Relocatable Power Taps.
 - d. 1449, Standard for Surge Protective Devices.
- B. Qualifications:
 - 1. Provide devices for a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
 - 2. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

- A. Clamping Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.
- B. Let-Through Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.
- C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

- D. Maximum Surge Current:
1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 PCT deviation of clamping voltage at a specified surge current.
 2. Listed by mode, since number and type of components in any SPD may vary by mode.
- E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).
- F. Surge Current per Phase:
1. The per phase rating is the total surge current capacity connected to a given phase conductor.
 2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
 - a. The N-G mode is not included in the per phase calculation.
- G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

1.4 SUBMITTALS

- A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. Shop Drawings:
1. For named products, submit only a catalog cut sheet.
 - a. For all other products, submit the data required below.
 2. See Specification Section 40 61 13 for general process control systems requirements.
 3. Product technical data for non-specified models:
 - a. Manufacturer's experience.
 - b. Standard catalog cut sheet.
 - c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
 - d. Create a Product Data Sheet for each different model number of SPD provided.
 - 1) Data in the Product Data Sheet heading:
 - a) SPD Type per PART 2 of the Specification.
 - b) Manufacturer's Name.
 - c) Product model number.
 - 2) Data in the Product Data Sheet body:
 - a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
 - b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
 - 3) Data in the Product Data Sheet closing:
 - a) Signature of the manufacturer's official (printed and signed).
 - b) Title of the official.
 - c) Date of signature.
- C. Contract Closeout Information:
1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 WARRANTY

- A. The manufacturer shall provide a minimum of a 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers model numbers listed in the individual product paragraphs below are acceptable.

2.2 CATEGORY IC1 SPD

- A. Approved Products:
1. Eaton AGPH 12015.
 2. ASCO 252 Series HSP121BT-1RU.
 3. MTL MA15/D/1/SI.
 4. Phoenix Contact SFP 1-20/120AC (2856702).
- B. Standards: UL 1449.
- C. Design:
1. General:
 - a. Mounted internally to control panels for point-of-use loads.
 - b. MOV based or multi-stage hybrid solid state high performance suppression system.
 - c. Designed for series connection.
 - d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
 - e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
 - f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
 2. Operating voltage: 120 VAC.
 3. Operating current: 15 A minimum.
 4. Operating frequency: 45 to 65 Hz.
 5. Modes of protection: All modes, L-N, L-G and N-G.
 6. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
 7. Maximum surge current: 20,000 A per phase, 10,000 A per mode minimum.
 8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 PCT deviation of the clamping voltage.
 9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection.
 - a. External protection as recommended by manufacturer.
 10. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 DEG phase angle:

System Voltage	Test Mode	IEEE C62.41.2		UL 1449 (3 rd Edition VPRs)
		B Comb. Wave	A Ring Wave	
L-N = 120 V	L-N	400 V	300 V	400 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	500 V

2.3 CATEGORY IC3 SPD

- A. Approved Products:
1. ASCO 205120NF010AN3D0.
 2. MTL MA-15/D/1/SI.
 3. MTL SD-150X.
 4. Phoenix Contact TTC Series.
 5. Phoenix Contact PLT-SEC-T3-120-FM.

- B. Standards: UL 497B or UL 1449.
- C. Design:
 - 1. General:
 - a. Mounted internally to control panels for point-of-use loads.
 - b. Multi-stage hybrid solid state high performance suppression system.
 - c. Designed for series connection.
 - d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
 - e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
 - f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
 - 2. Operating voltage: 120 VAC.
 - 3. Operating current: 3 A minimum.
 - 4. Operating frequency: 45 to 65 Hz.
 - 5. Modes of protection: L-N; when ground conductor is present L-G and N-G.
 - 6. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
 - 7. Maximum surge current: 6000 A per phase, 3000 A per mode minimum.
 - 8. Minimum repetitive surge current capacity:
 - a. The SPD shall meet one of the following:
 - 1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
 - 2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
 - 3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
 - 4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
 - 9. Maximum clamping voltages, measured from the zero voltage reference:
 - a. The SPD shall meet one of the following:
 - 1) 400A, 10x700 microsecond waveform: 200 PCT of system voltage.
 - 2) IEEE B3 combination wave: 250 PCT of system voltage.
 - 3) IEEE B3 ring wave: 200 PCT of system peak voltage.
 - 4) IEEE A3 ring wave: 200 PCT of system peak voltage.
 - 5) Mode N-G clamping voltage may be 175 PCT higher than the L-G levels.

2.4 CATEGORY IC4 SPD

- A. Approved Products:
 - 1. ASCO 157D036S10KXW5R0, 157D036S10KXW5S0, 157D036S10KXW6M0, or 157D036S10KXW6P0.
 - 2. MTL TP48-NDI.
 - 3. Phoenix Contact SURGETRAB/PIPETRAB Series.
- B. Standards: None.
- C. Design:
 - 1. General:
 - a. For protection of field mounted equipment connected to 4-20mA analog signal loops.
 - b. Mounted directly to an unused conduit entry on a process transmitter housing.
 - c. Multi-stage hybrid solid state high performance suppression system.
 - d. Designed for series connection.
 - e. Enclosure: 1/2 IN to 3/4 IN stainless steel conduit pipe nipple.
 - 2. Operating voltage: 24 VDC or as indicated on the Drawings.
 - 3. Modes of protection: All modes, L-L and L-G.
 - 4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
 - 5. Maximum surge current: 10,000 A.
 - 6. Minimum repetitive surge current capacity:
 - a. The SPD shall meet one (1) of the following:
 - 1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
 - 2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
 - 3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.

- 4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
- 5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L:
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
 - 3) IEEE B3 combination wave: 250 PCT of system voltage.
8. Maximum clamping voltages, L-G:
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
 - 3) IEEE B3 combination wave: 300 PCT of system voltage.

2.5 CATEGORY IC5 SPD

- A. Approved Products:
 1. ASCO 105D036S10KAN3D0 or 175D036S10KAPCN0 with PCB1B base.
 2. MTL SD32 or SD32X.
 3. Phoenix Contact TTC Series.
- B. Standards: UL 497B.
- C. Design:
 1. General:
 - a. Mounted internally to control panels for protection of equipment connected to analog signal loops.
 - b. Multi-stage hybrid solid state high performance suppression system.
 - c. Designed for series connection.
 - d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
 - e. Field connection: The unit shall have external terminal screws for line and ground conductors.
 2. Operating voltage: 24 VDC or as indicated on the Drawings.
 3. Modes of protection: All modes, L-L and L-G.
 4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
 5. Maximum surge current: 10,000 A.
 6. Minimum repetitive surge current capacity:
 - a. The SPD shall meet one of the following:
 - 1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
 - 2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
 - 3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
 - 4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
 - 5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
 7. Maximum clamping voltages, L-L:
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
 - 3) IEEE B3 combination wave: 225 PCT of system voltage.
 8. Maximum clamping voltages, L-G:
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
 - 3) IEEE B3 combination wave: 300 PCT of system voltage.

2.6 CATEGORY IC6 SPD

- A. Approved Products:
 1. ASCO 265120NF015BD4J0.
 2. MTL TPAC-4W.

3. Phoenix Contact BXT-N4X 4-Wire.
- B. Product:
1. Field mounted for protection of field mounted equipment connected to 120 V power and 4 - 20 mA analog signal loops.
 2. Category IC1 and Category IC5 SPDs mounted in a common enclosure.
 3. Enclosure: Metallic or nonmetallic NEMA 4X.

2.7 CATEGORY IC8 SPD

- A. Approved Products:
1. ASCO 175 Series.
 2. MTL SD Series.
 3. Phoenix Contact: TTC Series.
- B. Standards: UL 497B.
- C. Design:
1. General:
 - a. Mounted internally to control panels for protection of equipment connected to data lines (RS485, RS232, telephone line, etc.).
 - b. Multi-stage hybrid solid state high performance suppression system.
 - c. Designed for series connection.
 - d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
 - e. Field connection: Provide unit with external terminal screws for line and ground conductors.
 2. Operating voltage: Nominal unit operating voltage and configuration as specified or as indicated on the Drawings.
 3. Modes of protection: All modes.
 4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
 5. Maximum surge current: 10,000 A.
 6. Minimum repetitive surge current capacity:
 - a. The SPD shall meet one of the following:
 - 1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
 - 2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
 - 3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
 - 4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
 - 5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
 7. Maximum clamping voltages, L-L (Pos-Neg):
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
 - 3) IEEE B3 combination wave: 250 PCT of system voltage.
 8. Maximum clamping voltages, L-G:
 - a. The SPD shall meet one of the following:
 - 1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
 - 2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
 - 3) IEEE B3 combination wave: 300 PCT of system voltage.

2.8 SOURCE QUALITY CONTROL

- A. Performance tests to be performed or independently verified by a certified testing laboratory.
- B. The SPD are to be tested as a complete SPD system including: Integral unit level and/or component level fusing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Category IC1 SPD:
 - 1. Provide on the following applications:
 - a. Incoming 120 V power to all control panels.
 - 2. Connected in series with the panel's or equipment's branch circuit.
 - 3. Provide fuse protection as recommended by manufacturer.
 - 4. Flange mount or DIN rail mount in control panel.
 - 5. Connect all SPDs in the panel to the same grounding point.
- C. Category IC3 SPD:
 - 1. Provide on the following applications:
 - a. 120 V discrete alarm annunciator signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
 - 2. Connected in series with the equipment.
 - 3. Provide fuse protection as recommended by manufacturer.
 - 4. Flange mount or DIN rail mount in control panel.
 - 5. Connect all SPDs in the panel to the same grounding point.
- D. Category IC4 SPD:
 - 1. Provide on the following applications:
 - a. Loop powered transmitter (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
 - b. Loop powered transmitter (flow, level, etc.) where both the transmitter and control panel are mounted outdoors and the signal conductors are routed above grade or underground.
 - 2. Connect in series with the equipment.
 - 3. Attach to spare conduit entry of transmitter or inline of conduit at the transmitter.
 - 4. Bond transmitter to a grounded structure or provide a ground rod.
 - 5. Ground shield at control panel end.
 - 6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.
- E. Category IC5 SPD:
 - 1. Provide on the following applications:
 - a. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
 - b. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where both the transmitter and control panel are mounted outdoors and the signal conductors are routed above grade or underground.
 - 2. Connect in series with the equipment.
 - 3. Flange mount or DIN rail mount in control panel.
 - 4. Connect all SPDs in the control panel to the same grounding point.
 - 5. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.
- F. Category IC6 SPD:
 - 1. Provide on the following applications:
 - a. Outdoor field mounted transmitter (flow, level, etc.) that requires 120 V power and provides a 4-20 mA signal to a control panel where the conductors are routed above grade or underground.
 - 2. Connect in series with the equipment.
 - 3. Mounted adjacent to equipment.

4. Bond transmitter to a grounded structure or provide a ground rod.
 5. Ground shield at control panel end.
 6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.
- G. Category IC8 SPD:
1. Provide on the following applications:
 - a. On both ends of data lines that interconnect devices that are locked outdoors or in remote buildings or structures where the conductors are routed above grade or underground.
 - 1) Telephone modem.
 2. Connect in series with the equipment.
 3. Flange mount or DIN rail mount in control panel.
 4. Connect all SPDs in the control panel to the same grounding point.
 5. Verify SPDs series resistance and capacitance does not interfere with the data line signal.

END OF SECTION

SECTION 40 66 16

CLOSED-VESSEL LOW-PRESSURE, HIGH-INTENSITY ULTRAVIOLET EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. All labor, materials, equipment and appurtenances required for the enclosed vessel, pressurized flow, amalgam lamp based, ultraviolet (UV) systems illustrated and scheduled on the Drawings and as specified in this specification. The UV systems are to be complete and operational with all control equipment and accessories as shown and specified.

1.2 RELATED REQUIREMENTS

- A. Related Specification Sections include but are not necessarily limited to:
 - 1. General Conditions of the Contract for Construction AIA Document (A201-2017) and WV Supplementary Conditions to AIA Document (A201-2017).
 - 2. Division 01 - General Requirements.
 - 3. Division 26: Electrical.

1.3 SUBMITTALS

- A. All submittals are to comply with submission and content requirements specified within Specification Section 01 33 00.
- B. The Contractor shall submit shop drawings and product literature including all pertinent information for the proposed equipment such as dimensions, manufacturer, capacity, type, curves, certifications, accessories, physical and performance data, finishes, materials, location, layouts and wiring diagrams, etc.
- C. The Contractor shall submit Installation, Operation, and Maintenance Manuals weeks before training. These manuals shall contain complete wiring diagrams and schematics, parts lists, system operational data, dosage tables (based upon the range of field conditions, i.e., % transmissions and water flow rates), and drawings for the UV disinfection equipment supplied. The shop drawings and product literature may satisfy some of the requirements for the manuals, but it is the Contractor's responsibility to provide complete manuals.

1.4 QUALITY ASSURANCE

- A. The UV systems shall be from a manufacturer that has had similar systems in the same vessel configuration with the same lamps pre-validated by a third party per USEPA UVDGM or NWRI protocol. Documentation shall be submitted.

1.5 WARRANTIES

- A. The Contractor shall provide a Manufacturer's written warranty that provides:
 - 1. For full replacement of all defective lamps within the first 8,760 hours of operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (1ST LISTED IS BASIS OF DESIGN)

- A. UltraAqua represented by Innovasea
- B. SITA represented by Integrated Aqua Systems
- C. Glasco Ultraviolet
 - 1. IL 6000-10

2.2 GENERAL REQUIREMENTS

- A. Provide UV systems complete with UV reactor(s), control panel(s), UV intensity monitoring system(s), and all accessories herein specified and indicated in the Drawings.
- B. To be acceptable, the UV system must operate in enclosed vessels and use amalgam UV lamps. The UV system must be designed to fit within the piping configuration shown on the Drawings, without compromise of clearances or hydraulic performance criteria.
- C. UV lamp ballasts shall be tested for no more than 10% total harmonic distortion and UV system shall generate no more than 10% total harmonic distortion. Contractor shall have total harmonic distortion measured to demonstrate compliance.
- D. See Schedule in Drawings for performance.

2.3 DESIGN, CONSTRUCTION, AND MATERIALS

- A. General
 - 1. All components in contact with the process water shall be Type 316L stainless steel which has been passivated, mechanically polished and electro-polished.
 - 2. All material exposed to UV light shall be Type 316L stainless steel, Type 219 quartz or a suitably UV resistant material. Type 214 quartz also allowed.
 - 3. The system shall be designed for complete immersion of the UV lamps including electrode with the full length of the lamp in the water. All lamp electrical connections shall be at one end of the UV lamp. The major axis of the UV lamps shall be parallel to the direction of flow in the reactor.
 - 4. System shall have electric motor lamp sleeve wipers.
- B. UV Reactor
 - 1. Each UV reactor shall be manufactured from seamless stainless steel tubing.
 - 2. Each UV reactor shall have a drain port fixed to its outer wall.
 - 3. Each UV reactor shall accept its respective UV lamps and quartz sleeves through only one end of the vessel. This end of the UV reactor shall allow for complete reactor entry so internal inspection and/or service can be accomplished.
 - 4. The service side of the UV reactor and the UV lamp sleeve seals shall be made using suitable O-ring materials.
 - 5. UV reactors shall be able to operate safely at a maximum inlet pressure of 150 psi and tested to 225 psi. Inlet pressure 145 psi and test pressure 188 psi also allowed.
 - 6. Each UV reactor shall have a UV intensity sensor that can be removed and cleaned.
- C. UV Lamps
 - 1. The filament shall be significantly rugged to withstand shock and vibration.
 - 2. Lamp bases shall be resistant to UV and ozone.
 - 3. All electrical connections to the UV lamp shall be terminated at one end.
 - 4. UV lamps shall have a lamp base design that prevents arcing between electrical pins.
 - 5. UV lamps shall have a monochromatic spectral output, with the emissions peaking at 254 nanometers.
 - 6. The type of quartz used for lamp manufacture shall be compatible with wavelength emission.
 - 7. The mercury contained in the lamps shall be mixed with a base metal and fixed to the inside wall of the UV lamp quartz.
- D. Lamp End Seal and Lamp Holder
 - 1. The open end of the UV lamp sleeves shall be sealed to the sleeve guide by a suitable compression O-ring.
 - 2. O-ring compression shall be made by a sleeve nut, which shall require no special tools for installation or removal.
 - 3. Each UV lamp electrical connection shall incorporate a sealing boot which is held firmly in place by the sleeve nut to prevent emission of ultraviolet rays. Twist lock connections also allowed.

- E. UV Lamp Sleeves
 - 1. Clear fused quartz tubing, closed at one end shall be used. Type 219 quartz shall be used for disinfection and ozone destruction applications. Type 214 quartz also allowed.
- F. Electronic Power Supplies
 - 1. Each pair of UV lamps shall be powered by one electronic power supply. One power supply per lamp also acceptable.
 - 2. The electronic power supply shall not be frequency dependent.
 - 3. Each lamp within the pair shall operate on its own circuit within the power supply so as to prevent consecutive lamp failures should one lamp fail.
- G. Electrical
 - 1. Each UV reactor shall be powered from a remote mountable System Control Center by means of a waterproof cable interfacing with a watertight strain relief.
 - 2. The System Control Center shall be of painted steel construction.
 - 3. System Control Center shall be stainless steel or epoxy coated steel with electrical rating NEMA 4 or IP56 or better.
 - 4. Provide transformers from the UV manufacturer if system requires voltage other than the site voltage scheduled on the Drawings.
- H. Control and Instrumentation
 - 1. System control shall be microprocessor based. Operator interface is to be display type only and be located indoors.
 - 2. The local displays main screen shall allow the operator to view current system operating statuses; providing information inclusive of: UV intensity, UV dose, system operating hours, total number of lamps operating, power level of ballasts, and any alarm conditions. Display shall allow the operator to further view alarm conditions and history, system configuration/settings, and operation.
 - 3. Controller shall be capable of taking in a 4-20 mA input proportional to flow in gallons per minute. Controller shall calculate dose given flow and its own intensity and shall display dose and controller shall allow user to set a low dose alarm.
 - 4. Alarm Conditions:
 - a. The microprocessor based local display shall allow the operator to access and view the following alarm conditions:
 - 1) Individual lamp failure – failed lamps shall be indicated by specific address (i.e. lamp #). Position in the reactor shall be indicated via lamp numbers fixed to the lamp wiring at the service end of the UV reactor.
 - 2) UV dose and Low UV dose Alarm – Intensity to be monitored by a silicon carbide diode with UV dose displayed in mWs/cm². A low UV alarm will occur once minimum design UV dose has been exceeded. Units mJ/cm² also acceptable.
 - 3) Lamp life status – at the end of UV lamp(s) lifetime (8,500 hours) the elapsed time meter will flash continually for the next 240 hours to alert the operator that all lamps in the reactor require change out. A lamp life status indicator light that changes from green to orange or red for operator attention is also acceptable.
 - 5. Alarm Signals:
 - a. System shall have a normally open contact so that an alarm condition can be remotely sensed.

2.4 SAFETY EQUIPMENT

- A. Two (2) Face Shield(s), able to block UV light wavelengths between 200 and 400nm.

2.5 SPARE PARTS

- A. Furnish one spare wiper motor for the three vessels altogether. For each vessel furnish a complete set of spare lamps, lamp sleeves and seals.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall install the UV Systems per the Equipment Manufacturer's directions and the project Drawings. The Contractor will provide all required supports and anchoring required to install the UV units. The plumbing and electrical connections shall be provided as detailed on the Drawings and specifications. The Equipment Manufacturer will provide adequate crating and protection of the UV Systems for shipment to the project site. Installation instructions will be provided that specifically outline installation of the UV system. Lifting instructions will be provided to assist the Contractor in placing the units in the mechanical room.

3.2 START-UP AND COMPONENT VERIFICATION

- A. Prior to startup the Contractor shall have attained complete Operation and Maintenance Manuals from the supplier and submitted at least one copy to the Architect/Engineer's corporate home office. Another copy shall be kept at the site and made accessible to the Architect/Engineer. Other copies shall be per Division 1.
- B. After the Contractor confirms that scheduled flowing water will be available to pass through the UV units, the Contractor shall arrange to have a factory-authorized field technician to the project site for the purpose of verification of installation of the equipment and initial equipment start-up and trouble-shooting. The technician shall also train the Contractor how to operate the UV equipment so that the Contractor can demonstrate operation to the A/E during the Component Verification visit. This shall occur weeks prior to agency training and last 4 hours duration.

3.3 AGENCY TRAINING

- A. The Contractor shall have a factory authorized field technician review the installation, operate the UV equipment using hatchery water and give 4 hrs hands-on training to the using Agency staff on how to operate and maintain the equipment. The Contractor shall coordinate the scheduling of this visit with the hatchery manager and the UV equipment maker's authorized representative. This shall not be during the same week as Start-Up or Component Verification.
- B. The Contractor shall make a factory-authorized field technician make one visit between 3 and 9 months after Agency Training at a time agreed upon by the hatchery manager for a period of four (4) working hours each trip for the purpose of inspection of the equipment and training the facility personnel on proper operation and maintenance procedures.

END OF SECTION

SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements for control panels and enclosures utilized as follows:
 - a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Section 40 67 63, Section 40 71 00, Section 40 72 00, Section 40 73 00, Section 40 78 00, or Section 40 61 43.
 - b. This Section is only applicable to panels furnished with equipment specified in other specification divisions when so stated in the applicable equipment specification section.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 10 14 00 - Identification Devices.
 - 4. Division 11 - Equipment.
 - 5. Division 26 - Electrical.
 - 6. Section 40 61 13 - Process Controls Systems General Requirements.
 - 7. Section 40 61 21 - Process Control System Testing.
 - 8. Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
 - 9. Section 40 67 63 – Uninterruptible Power Supply.
 - 10. Section 40 71 00 - Flow Measurement.
 - 11. Section 40 72 00 - Level Measurement.
 - 12. Section 40 73 00 - Pressure, Strain, and Force Measurement.
 - 13. Section 40 75 00 - Process Liquid Analytical Measurement.
 - 14. Section 40 78 00 - Panel Mounted Instruments.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American National Standards Institute (ANSI).
 - 2. ASTM International (ASTM):
 - a. B75, Standard Specification for Seamless Copper Tube.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 4, Industrial Control and Systems: Terminal Blocks.
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC):
 - 1) Article 409, Industrial Control Panels.
 - 2) Article 504, Intrinsically Safe Systems.
 - 5. Underwriters Laboratories, Inc. (UL):
 - a. 508A, Standard for Safety Industrial Control Panels.
 - b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
 - c. 913, Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
- B. Qualifications:
 - 1. See Section 40 61 13 - Process Control Systems General Requirements.

- C. Miscellaneous:
 - 1. Approved supplier of Industrial Control Panels under provisions of UL 508A or UL 698A.
 - a. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
 - b. Control panel(s) without an affixed UL 508A or UL 698A label shall be rejected and sent back to the Contractor's factory.

1.3 DEFINITIONS

- A. Panel: Control panels or enclosures listed in the schedule included in this Specification Section.
- B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.
- C. Intrinsically Safe:
 - 1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
 - 2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.
- D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.
- E. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
- F. Instrumentation Cable:
 - 1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
 - 2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.
- G. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.
- H. Highway Addressable Remote Transducer (HART): a bi-directional communication protocol that provides data access between intelligent field instruments and host systems.
- I. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.
- J. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 40 61 13.
 - 2. Prepared with computer aided design (CAD) software.
 - 3. Printed on 11 by 17 IN sheets.
 - 4. Drawings shall include a title block containing the following:
 - a. Plant or facility name where panel(s) are to be installed.
 - b. Drawing title.
 - c. Drawing number.
 - d. Revision list with revision number and date
 - e. Drawing date.
 - f. Drawing scale.
 - g. Manufacturer name, address, and telephone number.
 - 5. Cover sheet for each drawing set shall indicate the following:
 - a. Plant or facility name.
 - b. Project name.

- c. Submittal description.
 - d. Revision number.
 - e. Issue date.
- 6. Table of contents sheet(s) shall indicate the following for each drawing in the set:
 - a. Drawing number.
 - b. Drawing title.
 - c. Sheet number.
- 7. Legend and abbreviation sheet shall indicate the following:
 - a. Description of symbols and abbreviations used.
 - b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
 - c. Confirmation that the panel(s) are to be affixed with a UL 508A or UL 698A label prior to shipment from the factory.
- 8. Bill of Material for each panel shall include the following component information:
 - a. Instrument tag number.
 - b. Quantity.
 - c. Functional name or description.
 - d. Manufacturer.
 - e. Complete model number.
 - f. Size or rating.
- 9. Panel exterior layout drawings to scale and shall indicate the following:
 - a. Panel materials of construction, dimensions, and total assembled weight.
 - b. Panel access openings.
 - c. Conduit access locations.
 - d. Front panel device layout.
 - e. Nameplate schedule:
 - 1) Nameplate location.
 - 2) Legend which indicates text, letter height and color, and background color.
 - 3) Short Circuit Current Rating (SCCR) marking per NFPA 70 or statement of exception. Include any required calculations.
 - f. Alarm annunciator window engraving schedule.
 - g. Layouts of graphic panels or mosaic displays.
- 10. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
 - a. Sub-panel or mounting pan dimensions.
 - b. Interior device layouts.
 - c. Wire-way locations, purpose, and dimensions.
 - d. Terminal strip designations.
 - e. Location of external wiring and/or piping connections.
 - f. Location of lighting fixtures, switches and receptacles.
- 11. Wiring diagrams shall consist of the following:
 - a. Panel power distribution diagrams.
 - b. Control and instrumentation wiring diagrams.
 - c. Internal network connections diagram
 - d. Wiring diagrams shall identify each wire as it is to be labeled.
- B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.
- C. Electrical load calculations for each panel:
 - 1. Total connected load.
 - 2. Peak electrical demand for each panel.
- D. Climate control calculations for each panel.
 - 1. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
- E. Unwitnessed Factory Testing confirmation of completion.

- F. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. See Section 40 61 13.
- G. Informational Submittals:
 - 1. Record Drawings:
 - a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
 - b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Enclosures:
 - a. Hoffman Engineering Co.
 - b. Rittal.
 - c. Hammond Manufacturing.
 - d. Saginaw Control & Engineering.
 - 2. Panel heaters:
 - a. Hoffman Enclosures, Inc.
 - b. Rittal.
 - c. Hammond Manufacturing.
 - 3. Heat exchangers and air conditioners:
 - a. Hoffman Enclosures, Inc.
 - b. Rittal.
 - c. Hammond Manufacturing.
 - 4. Cooling fans and exhaust packages:
 - a. Hoffman Enclosures, Inc.
 - b. Rittal.
 - 5. Internal corrosion inhibitors:
 - a. Hoffman Enclosures, Inc.; Model A-HCI.
 - b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
 - c. Cortec Corporation; Model VpCI Emitting Systems.
- B. Submit request for substitution in accordance with Section 01 25 00.

2.2 ACCESSORIES

- A. Panel Nameplates and Identification:
 - 1. See Section 10 14 00.

2.3 FABRICATION

- A. General:
 - 1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
 - 2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
 - 3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
 - a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
 - b. The window shall maintain the required NEMA rating of the enclosure.

4. Panel(s) shall be completely assembled at the Contractor's factory.
 - a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
 5. Painting:
 - a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
 - 1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
 - 2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
 - 3) Utilize solvent or chemical methods to clean panel surfaces.
 - 4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
 - 5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
 - 6) Bake powder coating at high temperatures to bond coating to enclosure surface.
 - a) Panel interior shall be white with semi-gloss finish.
 - b) Panel exterior shall be ANSI #61 gray with flat finish.
 - 7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
 - b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
 6. Finish opening edges of panel cutouts to smooth and true surface conditions.
 - a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
 7. Panels shall meet all requirements of UL 508A or UL 698A.
 - a. If more than one disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one disconnect switch required to de-energize the equipment before servicing."
 8. Provide control panel in accordance with NFPA 70, Article 409.
 - a. In the event of any conflict between NFPA 70, Article 409 and UL 508A or UL 698A, the more stringent requirement shall apply.
 9. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - a. Determine the SCCR rating by one of the following methods:
 - 1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 - 2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - 3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
 - c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.
- B. Free-Standing Panels:
1. Welded construction.
 2. Completely enclosed, self-supporting, and gasketed, dust-tight.
 3. Rolled lip around all sides of enclosure door opening.
 4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
 5. Full height, fully gasketed flush pan doors.
 6. Full length piano hinges rated for 1.5 times door plus instrument weight.
 7. Doors with keyed alike locking handles and three-point catch.
 8. Appropriate conduit, wiring, and instrument openings shall be provided.
 9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Internal Panel Wiring:

1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
 - a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
 - b. Follow wire-duct manufacturer's recommended fill limits.
 - c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
 - d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Wiring shall be installed such that if wires are removed from one device, source of power will not be disrupted to other devices.
3. Splicing and tapping of wires permitted only at terminal blocks.
4. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
 - a. Protect bend area with sleeve.
5. Arrange wiring neatly, cut to proper length, with surplus wire removed.
 - a. Arrange wiring with sufficient clearance.
 - b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
6. AC circuits shall be routed separate from analog signal cables and digital signal cables.
 - a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.
7. Separation of intrinsically safe circuit conductors and non-intrinsically safe circuit conductors:
 - a. Secure conductors so that any intrinsically safe circuit conductor that might come loose from a terminal is unlikely to come into contact with another terminal.
 - b. Separate non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by one of the following methods:
 - 1) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by at least 2 IN (50 MM).
 - 2) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of a grounded metal partition 0.0359 IN (0.91 MM) or thicker.
 - 3) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of an approved insulating partition that extends to within 0.0625 IN (1.5 MM) of the enclosure walls.
 - 4) Where either (1) all of the intrinsically safe circuit conductors or (2) all of the non-intrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.
8. Separate different intrinsically safe circuit conductors from each other by one of the following means:
 - a. The conductors of each circuit are within a grounded metal shield.
 - b. The conductors of each circuit have insulation with a minimum thickness of 0.01 IN (0.25 MM).
9. Provide minimum clearance of 0.125 IN (3 MM) between uninsulated parts of intrinsically safe field wiring conductors connected to terminals and grounded metal or other conducting parts.
10. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
11. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DEGC.
 - a. Conductor size shall be as required for load and 16 AWG minimum.
 - b. Internal panel wiring color code:
 - 1) AC circuits:
 - a) Power wiring: Black.

- b) Control interconnections: Yellow.
 - c) Neutral: White.
 - d) Ground: Green.
 - 2) Low voltage DC circuits:
 - a) Power wiring: Blue.
 - b) Control interconnections: Violet.
 - 3) Foreign voltage circuits: Pink.
 - 4) Annunciator circuits: Red.
 - 5) Intrinsically safe circuits: Light Blue.
- 12. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
 - a. Conductor size: 18 AWG minimum.
 - b. Terminate shield drain conductors to ground only at one end of the cable.
- 13. High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4 - 20 mA DC analog signals are converted to 1 - 5 VDC signals.
 - a. Resistors located at terminal strips.
 - b. Resistors terminated using individual terminal blocks and with no other conductors.
 - c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
- 14. Analog signals for devices in separate enclosures shall not be wired in series.
 - a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
- 15. Wire and cable identification:
 - a. Wire and cables numbered and tagged at each termination.
 - b. Wire tags:
 - 1) Slip-on, PVC wire sleeves with legible, machine-printed markings.
 - 2) Adhesive, snap-on, or adhesive type labels are not acceptable.
 - c. Markings as identified in the Shop Drawings.
- D. Grounding Requirements:
 - 1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
 - 2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
 - 3. Bond electrical racks, chassis and machine elements to a central ground bus.
 - a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
 - 4. Bond the enclosure to the ground bus.
 - 5. It is imperative that good electrical connections are made at the point between the ground bus and enclosure.
 - 6. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
 - 7. Sub-panels and doors shall be bonded to ground.
 - 8. Associated apparatus (connected to intrinsically safe circuits) and associated cable shields:
 - a. Ground in accordance with the associated control drawing (drawing provided for the intrinsically safe circuit and which contains manufacturer's entity parameters).
- E. Termination Requirements:
 - 1. Wiring to circuits external to the panel connected to interposing terminal blocks.
 - 2. Terminal blocks rigidly mounted on DIN rail mounting channels.
 - 3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
 - 4. One side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
 - 5. Terminal block markings:
 - a. Marking shall be the same as associated wire marking.

- b. Legible, machine-printed markings.
 - c. Markings as identified in the shop drawings.
 - 6. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
 - 7. Terminal blocks with continuous marking strips.
 - a. Each terminal block shall be identified with machine printed labels.
 - 8. Terminals shall facilitate wire sizes as follows:
 - a. 120 VAC applications: Conductor size 12 AWG minimum.
 - b. Other: Conductor size 14 AWG minimum.
 - 9. Analog signal cable shield drain conductors shall be individually terminated.
 - 10. Install minimum of 20 percent spare terminals.
 - 11. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.
 - 12. Fused terminal blocks shall be used in the following circuits:
 - a. Control voltage is used to energize a solenoid valve.
 - b. DC power is connected to 2-wire, loop-powered instruments.
 - 13. Fused terminal blocks shall be provided with blown fuse indicators.
 - 14. When control circuits require more than one field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one field conductor per terminal block.
 - 15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
 - 16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.
 - 17. Intrinsically safe circuit termination:
 - a. Provide at least 0.25 IN (6 MM) clearance between two terminals for connection of field wiring of different intrinsically safe circuits, unless this clearance is permitted to be reduced by the control drawing this is provided for the intrinsically safe circuit and which contains manufacturer's entity parameters.
 - b. Identify intrinsically safe circuits at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing as required by NEC, Article 504.
- F. Component Mounting and Placement:
- 1. Components shall be installed per manufacturer instructions.
 - 2. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
 - 3. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.
 - 4. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
 - 5. Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor, unless otherwise shown in the Contract Documents.
 - 6. Locate power supplies with sufficient spacing for circulation of air.
 - 7. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
 - a. Fastening devices shall not project through the outer surface of the panel enclosure.
 - 8. Excess mounting space of at least 20 percent for component types listed below to facilitate future expansion:
 - a. Fuse holders.
 - b. Circuit breakers.
 - c. Control relays.
 - d. Time delay relays.
 - e. Intrinsically safe barriers and relays.
 - 9. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.

- a. Minimum of 2 IN separation between terminal strips and wire ducts.
- G. Power Distribution:
 - 1. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
 - a. Limit load to maximum of 80 percent of circuit breaker rating.
 - 2. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
 - a. Alarm annunciators.
 - 3. Each control panel with alarm annunciator components shall be furnished with power protection in the form of a double conversion UPS.
 - 4. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.
 - 5. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.
- H. Internal Panel Lighting and Service Receptacles:
 - 1. Panels less than or equal to 4 FT wide:
 - a. One electrical GFCI duplex receptacle.
 - b. One LED light fixture with manual switch(es).
 - 2. Panels or panel faces greater than 4 FT wide:
 - a. One duplex electrical GFCI receptacle per 6 FT of length.
 - b. LED lighting strip with manual switches.
- I. Environmental Controls:
 - 1. Indoor panels located in a designated electrical room or control room:
 - a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
 - b. Internal corrosion inhibitors.
 - 2. Indoor panels not located within a designated electrical room or control room:
 - a. Thermostat controlled heaters to maintain temperature approximately 10 DEGF above ambient for condensation prevention inside the panels.
 - b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
 - c. Internal corrosion inhibitors.
 - 3. Outdoor panels:
 - a. Outdoor temperature range of 0 DEGF through 120 DEGF.
 - b. Thermostat controlled heaters to maintain temperature approximately 10 DEGF above ambient dew point for condensation prevention inside the panels.
 - c. Outdoor temperature range of 0 DEGF through 120 DEGF.
 - d. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
 - e. Internal corrosion inhibitors.
 - 4. Environmental control components:
 - a. Panel heaters:
 - 1) Thermostat controlled.
 - 2) Fan driven.
 - 3) Components mounted in an anodized aluminum housing.
 - 4) Designed for sub-panel mounting.
 - 5) Powered from 120 VAC and protected with a dedicated circuit breaker.
 - b. Cooling fans and exhaust packages:
 - 1) Cooling fan with louver or grill and replaceable filter.
 - 2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.

- 3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
- 4) Fitted with replaceable, high-density foam or synthetic fiber.
- 5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
- 6) Powered from 120 VAC and protected with a dedicated circuit breaker.
- c. Heat exchangers and air conditioners:
 - 1) Dual-loop design to isolate panel interior air from exterior air.
 - 2) Thermostat controlled.
 - 3) Operate from 120 VAC and protected with a dedicated circuit breaker.
- d. Internal corrosion inhibitors:
 - 1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
 - 2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
 - 3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

2.4 UNWITNESSED FACTORY TESTING

- A. Inspect and test entire panel assembly to verify readiness for shipment or readiness for the Engineer and/or Owner to attend factory testing if specified in Section 40 61 21 - Process Control System Testing.
- B. Location: Panel fabricator's factory.
- C. Tests shall be fully documented and signed by the panel fabricator's factory supervisor.
- D. The panel shop shall fully test the control panel for correct wiring.
 1. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.
- E. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.
- F. The following functions shall be tested as a minimum:
 1. Verify functions of the panel(s) required by the Contract Documents.
 2. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
 3. Simulate and test each discrete signal at the field terminal strips.
 4. Simulate and test each analog signal using loop calibrators.
 5. Correct operation of all digital communication devices.
 6. Verify online and offline diagnostic tests and procedures.
- G. Deficiencies shall be corrected prior to requesting the Engineer and/or Owner to attend factory testing if specified, or prior to shipment from the Contractor's factory.

2.5 FACTORY ACCEPTANCE TESTING

- A. Perform Factory Acceptance Testing witnessed by the Owner and/or Engineer if specified in Section 40 61 21 - Process Control System Testing.

2.6 MAINTENANCE MATERIALS

- A. Extra Materials:
 1. Quantity of 25 percent replacement lamps for each type installed (minimum of 12 of each type).
 2. Minimum 12 replacement filters for each type installed.
 3. 1 QT of exterior finish touch-up paint.
 4. One complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install freestanding panels on 4 IN high concrete housekeeping pads.
- B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.
- C. Obtain approved panel layouts prior to installation of conduits.
- D. Install products in accordance with manufacturer's instructions.

3.2 SCHEDULE

- A. Control Panel Schedule:

TAG NUMBER	INSTALLATION LOCATION	ENCLOSURE RATING	UPS REQUIRED	ELEVATION DRAWING
AP100	Upper Site Hatchery Building	NEMA 4	YES	06E401
AP200	Lower Site Circular Tank Building	NEMA 4	YES	15E401

END OF SECTION

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SECTION 40 67 63
UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Uninterruptible Power Supplies (UPS).
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations, 47 CFR 15, Radio Frequency Devices.
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 1778, Standard for Uninterruptible Power Supply Equipment.

1.3 SUBMITTALS

- A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. Shop Drawings:
 - 1. See Section 40 61 13 - Process Control System General Requirements.
 - 2. Provide load calculations and manufacturer's runtime chart to substantiate UPS sizing.
- C. Contract Closeout Information:
 - 1. Operation and Maintenance Manuals:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

2.2 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. Manufacturers:
 - 1. APC Smart-UPS.
 - 2. Eaton 9PX.
 - 3. Liebert GXT5.
- B. Design and fabrication:
 - 1. Double conversion true online type.
 - 2. Tower type format.
 - 3. Waveform: Pure sine wave.
 - 4. Power factor correction.

5. Minimum 10 minutes power ride through of 100 PCT of connected load without incoming power.
 - a. Provide extended battery or batteries as necessary to achieve the specified battery run time.
6. For UPS and related components located within a server rack, install UPS and battery components at bottom of cabinet.
7. Frequency range: 45-65 Hz.
8. Input protection:
 - a. Fuse or circuit breaker.
9. Output voltage regulation:
 - a. ± 1 PCT online.
 - b. ± 2 PCT on battery mode.
10. Battery: Sealed, lead-acid; maintenance free.
11. Three stage battery charging for prolonged battery life.
12. Battery over discharge protection.
13. Input power cord.
14. Output receptacles.
15. Efficiency:
 - a. Normal mode, minimum: 89 PCT.
 - b. Efficiency mode, minimum: 95 PCT.
 - c. Battery mode, minimum: 83 PCT.
16. Operating temperature: 32 to 104 DEGF.
17. Relative humidity: 5-95 PCT non-condensing.
18. Integral bypass to automatically bypass UPS on selected fault conditions.
19. Front panel indication of UPS status and alarm conditions.
 - a. UPS Fault.
 - b. UPS on battery.
 - c. UPS is online and operating normally.
 - d. Battery low.
 - e. UPS in bypass.
20. Agency Approvals:
 - a. Safety: UL 1778.
 - b. Emissions: FCC Part 15 (Class A).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- A. Test UPS to verify the UPS switches power upon incoming AC power loss correctly while keeping all UPS powered loads online.
- B. Perform testing of the UPS to determine if each UPS is sized correctly to maintain the specified run time.

END OF SECTION

SECTION 40 71 00

FLOW INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Flow Transmitters:
 - a. Magnetic Flow Meters (Inline).
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - c. B16.5, Pipe Flanges and Flanged Fittings.
 - d. B626, Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Tube.
 - e. PTC 19.5, Application of Fluid Meters, Part 2.
 - 2. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 3. American Water Works Association (AWWA).
 - 4. National Sanitation Foundation (NSF).
 - a. 61, Municipal Water Systems Certification.
 - 5. US Department of Interior Bureau of Reclamation (USDIBR):
 - a. Water Measurement Manual.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 61 13.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

1.4 SYSTEM DESCRIPTION

- A. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 FLOW TRANSMITTERS

- A. Magnetic Flow Meters (Inline):
 - 1. Acceptable manufacturers:
 - a. Toshiba (Flange Mount Anywhere).
 - b. Endress+Hauser (Proline Promag W).
 - c. McCrometer (UltraMag).
 - d. Seametrics
 - 2. Materials:
 - a. Flanges: carbon steel or stainless steel.
 - b. Grounding rings: 316 stainless steel.
 - c. Electrodes: 316L stainless steel.
 - d. Meter lining shall be a material that will not degrade or oxide with prolonged exposure to high intensity ultraviolet light:
 - 1) PTFE.
 - 2) Fusion bonded epoxy.
 - e. Measuring tube: 304 stainless steel.
 - 3. Design and fabrication:
 - a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
 - b. Meter shall provide 0.5% of rate accuracy with as little as 1 pipe diameters of straight pipe run upstream of the meter flange and 0 pipe diameters downstream of straight pipe run of the meter center.
 - c. Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions. Meter body shall be rated to same pressure as the flanges.
 - d. Grounding requirements: Inlet and outlet grounding rings.
 - e. Pulsed DC magnetic field excitation.
 - f. Automatic zero.
 - g. Adjustable low flow cutoff.
 - h. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
 - i. 4-20 mA DC isolated output into maximum 750 ohms.
 - j. Power supply: 115 V $\pm$ 10 PCT, 60 Hz.
 - k. Indication of flow rate and totalized flow at transmitter.
 - l. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
 - m. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.
 - n. Transmitter electronics shall be integrally mounted to the flow tube unless indicated otherwise in the Drawings.
 - o. Provide all interconnecting cable(s) between sensor and transmitter. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings. Field verify actual conduit lengths prior to fabrication.
 - p. NSF 61 certified.
 - 4. Schedule:
 - a. Reference the flow meter schedule on Sheet 01D501.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

3.2 TRAINING

- A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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SECTION 40 72 00
LEVEL INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Level Switches:
 - a. Portable Level Switch
 - b. Float-Tilt Type Level Switch.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings.
 - 2. ASTM International (ASTM):
 - a. A106, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
 - b. A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 61 13.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

1.4 SYSTEM DESCRIPTION

- A. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 LEVEL SWITCHES

A. Portable Level Switch:

1. Acceptable Manufacturers
 - a. Cynergy3 Components: Part No. SLP4AP15.
 - b. Or approved equal.
2. Materials:
 - a. Float material: Buna-N or polypropylene.
 - b. Housing/body and shield: stainless steel.
 - c. Cable: PVC jacket.
3. Design and fabrication:
 - a. Cable suspended, single point liquid level switch with slosh shield.
 - b. Configurable to a make or break action on either rising or falling level.
 - c. Reed-switch contact suitable for switching signal levels up to 250 volts.
 - d. Contact ratings:
 - 1) Maximum switching power: 25VA.
 - 2) Maximum switching voltage (AC/DC): 250V.
 - 3) Maximum switching current: 0.6A.
4. Number of devices as indicated in the Schedule (or Instrument List) below:

TAG NUMBER	SERVICE
06-LSL01	Early Rearing Tank 01 Low Level
06-LSL02	Early Rearing Tank 02 Low Level
06-LSL03	Early Rearing Tank 03 Low Level
06-LSL04	Early Rearing Tank 04 Low Level
06-LSL05	Early Rearing Tank 05 Low Level
06-LSL06	Early Rearing Tank 06 Low Level
06-LSL07	Early Rearing Tank 07 Low Level
06-LSL08	Early Rearing Tank 08 Low Level
06-LSL09	Early Rearing Tank 08 Low Level
06-LSL10	Early Rearing Tank 10 Low Level
06-LSL11	Early Rearing Tank 11 Low Level
06-LSL12	Early Rearing Tank 12 Low Level
06-LSL13	Early Rearing Tank 13 Low Level
06-LSL14	Early Rearing Tank 14 Low Level
06-LSL15	Early Rearing Tank 15 Low Level
06-LSL16	Early Rearing Tank 16 Low Level
06-LSL17	Early Rearing Tank 17 Low Level
06-LSL18	Early Rearing Tank 18 Low Level
06-LSL19	Early Rearing Tank 19 Low Level
06-LSL20	Early Rearing Tank 20 Low Level
06-LSL21	Incubation Chilled Water Trough 1 Low Level
06-LSL22	Incubation Chilled Water Trough 2 Low Level
06-LSL23	Incubation Ambient Water Trough 1 Low Level

TAG NUMBER	SERVICE
06-LSL24	Incubation Ambient Water Trough 2 Low Level
15-LSL01	Rearing Tank 01 Low Level
15-LSL02	Rearing Tank 02 Low Level
15-LSL03	Rearing Tank 03 Low Level
15-LSL04	Rearing Tank 04 Low Level
15-LSL05	Rearing Tank 05 Low Level
15-LSL06	Rearing Tank 06 Low Level
15-LSL07	Rearing Tank 07 Low Level
15-LSL08	Rearing Tank 08 Low Level

B. Float-Tilt Type Level Switch:

1. Manufacturers:
 - a. Anchor Scientific Inc.
 - b. Consolidated Electric.
 - c. Contegra.
2. Materials:
 - a. Float material: Polypropylene or Teflon coated type 316 stainless steel.
 - b. Cable jacket: PVC, neoprene.
 - c. Cable clamp: Polypropylene or 316 stainless steel.
3. Design and fabrication:
 - a. Mercury-free switch.
 - b. Provide switch complete with flexible electrical cables.
 - c. SPDT contact rated at 1 amp at 120 VAC.
 - d. Direct acting float switch:
 - 1) Switch actuates on rising level.
 - 2) Switch deactuates when liquid falls 1 IN below actuation level.
 - e. Terminate cables in junction box.
 - f. Process temperature: max. 120 DEGF.
 - g. Install floats per drawing details.
 - h. Mounting Device: cable weight or mounting clamp as shown in the schedule.
 - i. Fail-safe contacts:
 - 1) High level applications – normally closed:
 - a) The contact switch turns on (closes) when the switch drops below horizontal signaling a not at high level condition, and turns off (opens) when the switch tips above horizontal.
 - 2) Low level applications – normally open.
 - a) The contact switch turns on (closes) when the switch tips above horizontal signaling a not at low level condition, and turns off (opens) when the switch drops below horizontal.
4. Schedule (or Instrument List):

TAG NUMBER	SERVICE	MOUNTING ELEVATION	MOUNTING (Suspended or Pipe)
03-LSL01	Concrete Raceway 01 Low Level	TBD	Pipe
03-LSL02	Concrete Raceway 02 Low Level	TBD	Pipe
03-LSL03	Concrete Raceway 03 Low Level	TBD	Pipe
08-LSL01	Asphalt Pond Low Level	TBD	Pipe

TAG NUMBER	SERVICE	MOUNTING ELEVATION	MOUNTING (Suspended or Pipe)
13-LSL01	Concrete Pond Low Level	TBD	Pipe

2.3 ACCESSORIES

- A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
 1. Materials, unless otherwise specified, shall be as follows:
 - a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
 - b. Mounting brackets:
 - 1) Standard: 316 stainless steel.
 - 2) Highly corrosive areas: Aluminum.
 - c. Mounting plates, angles:
 - 1) Standard: Carbon steel.
 - 2) Corrosive areas: 316 stainless steel.
 - d. Instrument pipe stands:
 - 1) Standard: Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.
 - 2) Corrosive areas: 316 stainless steel.
- B. Provide handheld communicator compatible for all intelligent transmitters furnished.
 1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
 2. If these features are provided with the intelligent transmitter that is accessible, the hand held communicator is not required.
- C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install instrument mounting pipe stands level and plumb.
- C. Instrument Valves:
 1. Orient stems for proper operation.
 2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
 3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
 4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
 - a. When cool, reassemble the valves.
 5. Support each valve individually.
 - a. The tubing system does not qualify as support for the valve.
- D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.
- E. Keep foreign matter out of the system.
- F. Remove all oil on piping and tubing with solvent before piping and tubing installation.
- G. Plug all open ends and connections to keep out contaminants.

H. Threaded Connection Seals:

1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

I. Instrument Mounting:

1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
 - a. Protect from heat, shock, and vibrations.
 - b. Provide accessibility for maintenance.
 - c. Free from interference with piping, conduit and equipment.

3.2 TRAINING

- A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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SECTION 40 73 00
PRESSURE INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pressure Switches.
 - 2. Pressure Indicators.
 - 3. Isolation Devices.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings
 - 2. ASTM International (ASTM):
 - a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 40 61 13.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 PRESSURE SWITCHES

- A. Electro-Mechanical:
 - 1. Manufacturers:
 - a. Allen-Bradley (Model 836).
 - b. Emerson / ASCO (S Series).
 - c. Mercoid (Series DA/DS or SA1100).
 - 2. Materials:
 - a. Wetted switch elements: 316 stainless steel.
 - b. Diaphragm seal housing: 316 stainless steel.
 - c. Pressure snubber:
 - 1) Filter disc: 316 stainless steel.
 - 2) Housing: 316 stainless steel.

3. Accessories:
 - a. Provide ball valve to isolate pressure switch from source.
 - b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on pressure switch as shown on schedule.
 - c. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
4. Design and fabrication:
 - a. Utilize "Snap Action" type contact switches.
 - b. No external power needed.
 - c. One SPDT contact rated:
 - 1) 0.5 amps inductive at 125 VDC.
 - 2) 5 amps inductive at 120 VAC.
 - d. Switch set points:
 - 1) Above 1,000 PSI:
 - a) Between 30 and 35 PCT of switch rated working range.
 - b) Operating pressure range not to exceed 35 PCT of switch rated working pressure.
 - 2) Below 1,000 PSI:
 - a) Set points between 30 and 70 PCT of switch rated working range.
 - b) Operating pressure not to exceed 75 PCT of switch rated working range.
 - e. Accuracy: ± 1 PCT of full scale.
 - f. Process connection: Minimum of 1/4 IN.
 - g. Conduit connection: Minimum of 1/2 IN.

2.3 PRESSURE INDICATORS

- A. Pressure Gauge - Mechanical:
 1. Manufacturers:
 - a. Ametek / USGauge (Solfrunt Model 1980).
 - b. Ashcroft (Type 1279 or 1379).
 2. Materials:
 - a. Bourdon tube, socket, connecting tube: 316 stainless steel.
 - b. Case: Phenolic.
 - c. Pressure snubber:
 - 1) Filter disc: 316 stainless steel.
 - 2) Housing: 316 stainless steel.
 3. Accessories:
 - a. Provide valve at point of connection to equipment and at panel if panel mounted.
 - b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on gauge applications as shown on schedule.
 - c. Provide 1/2 IN stainless steel anti-siphon pigtail inlet connection for hot water and steam applications.
 4. Design and fabrication:
 - a. All components suitable for service at:
 - 1) 250 DEGF.
 - 2) The maximum process temperature to which the gauge is to be exposed.
 - b. Provide viewer protection from element rupture.
 - c. Calibrate gauges at jobsite for pressure and temperature in accordance with manufacturer's instructions.

- d. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with dial diameter as follows:

PIPE SIZE	DIAL SIZE	GAUGE CONNECTION
1-1/2 IN or less	2-1/2 IN	1/4 IN
Larger than 1-1/2 IN	4-1/2 IN	1/2 IN

- e. Equip with white faces, black numerals and black pointers.
- f. Gauge tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
- 1) Gauge to be readable from an accessible standing position.
- g. Gauge accuracy: 1 PCT of full range.
- h. Select gauge range so that:
- 1) The normal operating value is in the middle third of the dial.
- 2) Maximum operating pressure does not exceed 75 PCT of the full scale range.

2.4 ISOLATION DEVICES

- A. Diaphragm Seal:
- Manufacturers:
 - Ametek.
 - Ashcroft.
 - Emerson Rosemount.
 - Materials:
 - Lower housing: 316 stainless steel or PVC.
 - Diaphragm material: 316 stainless steel or Teflon.
 - Design and fabrication:
 - Isolates instrument from process fluids which are corrosive or contain solids.
 - Upper housing with bleed screw.
 - Lower housing with flushing connection.
 - Fill fluid:
 - Utilize halocarbon fill for process applications involving strong oxidizing agents.
 - Agents include but are not limited to: Cl₂, KMNO₄, FeCl, NaOH, and NaOCl.
 - Utilize manufacturer's standard fill for other applications.
 - Ensure fill is suitable for application temperatures.
 - Process connections:
 - Instrument: 0.25 IN female NPT.
 - Process: 0.5 IN female NPT.
 - PVC pipe applications: Use a socket weld connection.
 - Installed where specified or shown on Drawings.

2.5 ACCESSORIES

- A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
- Materials, unless otherwise specified, shall be as follows:
 - Bolts, nuts, washers, expansion anchors: 316 stainless steel.
 - Mounting brackets:
 - Standard: 316 stainless steel.
 - Highly corrosive areas: Aluminum.
 - Mounting plates, angles:
 - Standard: Carbon steel.
 - Corrosive areas: 316 stainless steel.

- d. Instrument pipe stands:
 - 1) Standard: Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.
 - 2) Corrosive areas: 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install instrument mounting pipe stands level and plumb.
- C. Instrument Valves:
 - 1. Orient stems for proper operation.
 - 2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
 - 3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
 - 4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
 - a. When cool, reassemble the valves.
 - 5. Support each valve individually.
 - a. The tubing system does not qualify as support for the valve.
- D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.
- E. Keep foreign matter out of the system.
- F. Remove all oil on piping and tubing with solvent before piping and tubing installation.
- G. Plug all open ends and connections to keep out contaminants.
- H. Threaded Connection Seals:
 - 1. Use Tite-Seal or acceptable alternate.
 - 2. Use of lead base pipe dope or Teflon tape is not acceptable.
 - 3. Do not apply Tite-Seal to tubing threads of compression fittings.
- I. Instrument Mounting:
 - 1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
 - 2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
 - 3. Mount instruments level, plumb, and support rigidly.
 - 4. Mount to provide:
 - a. Protection from heat, shock, and vibrations.
 - b. Accessibility for maintenance.
 - c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

- A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 40 75 00
PROCESS LIQUID ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dissolved Oxygen Sensor and Analyzer.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SYSTEM DESCRIPTION

- A. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 40 61 13.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 ANALYTICAL ELEMENTS

- A. Dissolved Oxygen Sensor and Analyzer:
 - 1. Manufacturers:
 - a. Hach Company, model LDO[®] sensor and model sc200 controller (transmitter).
 - b. Endress + Hauser: Oxymax COS61series sensor and Liquiline CM400 series transmitter.
 - 2. Materials:
 - a. Sensor wetted parts: Noryl, Teflon, 316 stainless steel, PVC, polypropylene, PBT (thermoplastic polyesters based on polybutylene terephthalate), or PC (polycarbonate).
 - b. Sensor membrane: Polybutyl methoacrolate or Teflon.
 - c. If amperometric type sensor:
 - 1) Anode: Silver.

- 2) Cathode: Gold.
3. Design and fabrication:
 - a. Sensor:
 - 1) Utilize digital sensor capable of being calibrated with a lab analyzer and then connected to a second analyzer in the field without the need to recalibrate.
 - 2) Temperature compensated.
 - 3) Inaccuracy:
 - a) Dissolved oxygen: ± 0.2 PPM or ± 0.2 PCT of span at calibrating temperature.
 - b) Temperature: ± 0.5 DEGC.
 - 4) Response time: 95 PCT in 60 seconds.
 - 5) Internal calibration standard.
 - 6) Mounting: Per schedule below.
 - 7) Operating temperature: 32 to 104 DEGF.
 - 8) Spares:
 - a) Luminescent type sensors: One replacement sensor cap per sensor installed.
 - b) Electrochemical type sensors: One replacement sensor per each two (or fraction thereof) sensors installed.
 - b. Controller (analyzer/transmitter):
 - 1) Capable of receiving inputs from two sensors.
 - 2) Minimum 2-1/2 digit local LED or backlit LCD display.
 - a) 0.1 PPM resolution.
 - b) 0.1 DEGF resolution.
 - c) Menu driven.
 - d) Indication of sensor fault condition.
 - 3) Power supply: 24 VDC.
 - 4) Analog output signals:
 - a) Quantity: Two (one per sensor).
 - b) Isolated 4-20 mA DC, dissolved oxygen, into 500 ohms.
 - 5) Relay outputs:
 - a) Quantity: Four (two per sensor).
 - b) Electromechanical SPDT, Form C contacts.
 - 6) Operating temperature: 0 to 140 DEGF.
 - 7) Relative humidity: 95 PCT.
 - 8) Mounting: Per schedule below.
4. Schedule:

TAG NUMBER	SERVICE	MEASUREM ENT RANGE
15-AIT01	Circular Tanks Dissolved Oxygen 1	0-15 ppm
15-AIT02	Circular Tanks Dissolved Oxygen 2	0-15 ppm

2.3 ACCESSORIES

- A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
 1. Materials, unless otherwise specified, shall be as follows:
 - a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
 - b. Mounting brackets:
 - 1) Standard: 316 stainless steel.
 - 2) Highly corrosive areas: Aluminum.
 - c. Mounting plates, angles:
 - 1) Standard: Carbon steel.
 - 2) Corrosive areas: 316 stainless steel.

- d. Instrument pipe stands:
 - 1) Standard: Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.
 - 2) Corrosive areas: 316 stainless steel.
- B. Tubing Tray or Channel:
 - 1. Aluminum.
 - 2. Provide dielectric material between tray or channel and tubing.
- C. Provide handheld communicator compatible with all intelligent transmitters furnished.
 - 1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
 - 2. If these features are provided with the intelligent transmitter, the hand held communicator is not required (provided the transmitter is easily accessible by an operator without the need for a ladder/step stool).
- D. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install instrument mounting pipe stands level and plumb.
- C. Instrument Mounting:
 - 1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
 - 2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
 - 3. Mount instruments level, plumb, and support rigidly.
 - 4. Mount to provide:
 - a. Protection from heat, shock, and vibrations.
 - b. Accessibility for maintenance.
 - c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

- A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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SECTION 40 78 00

PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Annunciators.
 - 2. Pilot devices.
 - 3. Relays/timers.
 - 4. Termination equipment.
 - 5. Power supplies.
 - 6. Voltage surge protection devices.
 - 7. Intrinsic Safety Isolators.
 - 8. Horns.
 - 9. Alarm Dialers.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.
 - 4. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. The International Society of Automation (ISA):
 - a. S18.1, Annunciator Sequences and Specifications.
 - b. ANSI/ISA-12.02.02-2014, Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
- B. Miscellaneous:
 - 1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Control Drawings for intrinsically safe systems:
 - a. Print on 8-1/2 x 11 IN sheets.
 - b. In accordance with recommendations of ANSI/ISA-12.02.02-2014.
 - c. One control drawing per sheet.
 - d. Identify model numbers of both the associated apparatus and the intrinsically safe apparatus.
 - e. Include wiring diagram showing interconnections of the intrinsically safe apparatus and the associated apparatus.
 - f. Provide entity parameters for both the associated apparatus and the intrinsically safe apparatus.
 - g. Identify line of demarcation between classified (hazardous) and unclassified (nonhazardous) locations and identify equipment that is installed in each location.
 - h. Identify hazardous areas by class, groups, and divisions.

- i. Show maximum nonhazardous location voltage that may be used with the associated apparatus.
 - j. Include any specific conditions that are necessary to maintain the intrinsic safety protection.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.
- C. Submit request for substitution in accordance with Section 01 25 00.

2.2 ANNUNCIATORS

- A. Manufacturers:
 - 1. Ametek/Panalarm.
 - 2. Rochester Instrument Systems.
- B. Design and fabrication:
 - 1. Manual reset sequence per ISA S18.1.
 - 2. Utilize both audio and visual indication in accordance with ISA S18.1 diagrams and descriptions.
 - 3. 3 IN SQ individual lighted annunciator windows.
 - a. Half size windows as shown in the Drawings.
 - 4. Clearly identified nameplate for each annunciation window.
 - 5. Cabinet rating: NEMA 4.
 - 6. Lamps: LED.
 - 7. Microprocessor based logic.
 - 8. Pushbuttons providing following functions:
 - a. Lamp test.
 - b. Alarm acknowledge.
 - c. Alarm reset.
 - 9. Mount: Flush.
 - 10. Power source: 120 VAC, +10 PCT, 60 HZ.
 - 11. Provide power supply for field contact interrogation.
 - a. Field interrogation voltage: 125 VDC.
 - 12. Operating temperature rating: -40-140 DEGF.
 - 13. Humidity: 10 to 95 PCT non-condensing.
 - 14. Auxiliary repeat relays shall be provided for every input.
 - a. Configured to follow alarm input status.
 - b. Each relay shall be monitored by the alarm dialer.

2.3 PILOT DEVICES

- A. Selector Switches:
 - 1. Manufacturers:
 - a. Eaton.
 - b. Rockwell Automation (Allen-Bradley) - Bulletin 800H.
 - c. Schneider Electric - Class 9001.
 - d. GE - CR104P.

- e. Siemens - 52 Series.
- 2. Design and fabrication:
 - a. Heavy-duty type.
 - b. NEMA 4.
 - c. Rotary cam units conforming to NEMA ICS 2-216.22.
 - d. Mounting hole: 30.5 MM.
 - e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
 - f. UL listed.
 - g. Maintained contact type.
 - h. Knob type operators.
 - i. Black colored operators.
 - j. Designed with cam and contact block with approximate area of 2 IN SQ.
 - k. Legend plate marked per Contract Documents.
 - l. Contact block requirements:
 - 1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
 - 2) Wet or outside locations: Hermetically sealed contact blocks.
- B. Pushbuttons:
 - 1. Manufacturers:
 - a. Eaton.
 - b. Rockwell Automation (Allen-Bradley) - Bulletin 800H.
 - c. Schneider Electric - Harmony 9001K Series.
 - d. GE - CR104P.
 - e. Siemens - 52 Series.
 - 2. Materials:
 - a. Backing diaphragm: Buna-N.
 - 3. Design and fabrication:
 - a. Heavy-duty type.
 - b. NEMA 4.
 - c. Conforming to NEMA ICS 2-216.22.
 - d. Mounting hole: 30.5 MM.
 - e. Diaphragm backed.
 - f. UL listed.
 - g. Emergency stop pushbuttons to have mushroom head operator and two sets of maintained normally open (NO) and normally closed (NC) contacts. Emergency stop pushbutton shall be NEMA 4X rated.
 - h. Non-illuminated type:
 - 1) Momentary contact with necessary contact blocks.
 - 2) Molded, solid color melamine buttons.
 - 3) Standard flush operators with full shroud.
 - 4) Black colored buttons for START or ON and red color for STOP or OFF.
 - 5) Appropriate contact blocks to fulfill functions shown or specified.
 - i. Contact block requirements:
 - 1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
 - 2) Wet or outside locations: Hermetically sealed contact blocks.
 - 3) Legend plate marked per Contract Documents.
- C. Indicating Lights:
 - 1. Manufacturers:
 - a. Eaton.
 - b. Rockwell Automation (Allen-Bradley) - Bulletin 800H.
 - c. GE - CR104P.
 - d. Siemens - 52 Series.

2. Design and fabrication:
 - a. Heavy duty.
 - b. NEMA 4.
 - c. Type allowing replacement of bulb without removal from control panel.
 - d. LED.
 - e. UL listed.
 - f. Legend plate marked per Contract Documents.
 - g. Nominal 2 IN SQ face.
 - h. Mounting hole: 30.5 MM.
 - i. Push-to-test indicating lights.
 - j. Plastic lens.

2.4 RELAYS/TIMERS

- A. Program Timers:
 1. Manufacturers:
 - a. Tork.
 - b. Paragon Electric Company, Inc.
 2. Design and fabrication:
 - a. Microprocessor based.
 - b. Serve as time program actuator control of final control elements.
 - c. 24 HR time control.
 - d. Programmable from panel face keys.
 - e. Skip-A-Day feature allowing schedule to be skipped for an entire day or days.
 - f. DPDT switch contacts rated at 15 amps at 120 VAC.
 - g. Battery carryover to maintain time and program during power outage for 275 HRS.
- B. Reset Timer:
 1. Acceptable manufacturer:
 - a. Eagle Signal Controls.
 2. Design and fabrication:
 - a. Heavy duty.
 - b. Consisting of adjustable time delay with automatic reset feature when period is timed out.
 - c. Auxiliary relays as required to perform functions specified or shown on Drawings.
 - d. Operate on 117 VAC (+10 PCT) power source.
 - e. Nominal dimensions: 4 x 4 IN.
 - f. Switch rating: 10 amps.
 - g. Dial range: 60 minutes.
- C. Control Relays:
 1. Manufacturers:
 - a. Idec - RH Series.
 - b. TE Connectivity (Potter & Brumfield).
 - c. Rockwell Automation (Allen-Bradley) - Bulletin 700-HC.
 - d. Eaton - D Series.
 2. Design and fabrication:
 - a. Plug-in general purpose ice cube relay.
 - b. Pin connector type.
 - c. Switching capacity: 10 A.
 - d. Contact material: Silver cadmium oxide.
 - e. Provide relays with a minimum of 2DPDT contacts.
 - f. Coil voltage: 120 VAC.
 - g. Relay sockets are DIN rail mounted.
 - h. Internal neon or LED indicator is lit when coil is energized.
 - i. Clear polycarbonate dust cover with clip fastener.
 - j. Check button.

- k. Temperature rise:
 - 1) Coil: 85 DEGF max.
 - 2) Contact: 65 DEGF max.
 - l. Insulation resistance: 100 Meg min.
 - m. Frequency response: 1800 operations/hour.
 - n. Operating temperature: -20 to +150 DEGF.
 - o. Life expectancy:
 - 1) Electrical: 500,000 operations or more.
 - 2) Mechanical: 50,000,000 operations or more.
 - p. UL listed.
- D. Time Delay Relays:
- 1. Manufacturers:
 - a. Rockwell Automation (Allen Bradley) - Bulletin 700-HNC.
 - b. Idec - GT Series.
 - c. Eaton - TR Series.
 - 2. Design and fabrication:
 - a. Melt design test and performance requirements of NEMA ICS 2-218.
 - b. Heavy-duty.
 - c. Solid-state construction.
 - d. DPDT contacts.
 - e. External adjusting dial.
 - f. Auxiliary relays as required to perform functions specified or shown on Drawings.
 - g. Operates on 117 VAC (± 10 PCT) power source.
 - h. Contact rating: A150 per NEMA ICS 2-125.
 - i. Furnish with "on" and "timing out" indicators.

2.5 TERMINATION EQUIPMENT

- A. Terminal Blocks:
- 1. Manufacturers:
 - a. Phoenix Contact - UT-4.
 - b. Rockwell Automation (Allen-Bradley) - Bulletin 1492.
 - c. Weidmuller - SAK Series.
 - 2. Design and fabrication:
 - a. Modular type feed-through with screw compression clamp.
 - b. Screws: Stainless steel.
 - c. Current bar: Nickel-plated copper allow.
 - d. Thermoplastic insulation rated for -40 to +90 DEGC.
 - e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
 - f. Install end sections and end stops at each end of terminal strip.
 - g. Install machine-printed terminal markers on both sides of block.
 - h. Spacing: 6 MM.
 - i. Wire size: 22-12 AWG.
 - j. Rated voltage: 600 V.
 - k. Din rail mounting.
 - l. UL listed.
 - 3. Standard-type block:
 - a. Rated current: 30 A.
 - b. Color: Gray body.
 - 4. Bladed-type block:
 - a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
 - b. Rated current: 10 A.
 - c. Color:
 - 1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
 - 2) Foreign voltage entering enclosure: Orange body, orange switch.

5. Grounded-type block:
 - a. Electrically grounded to mounting rail.
 - b. Use to terminal ground wires and analog cable shields.
 - c. Color: Green and yellow body.
- B. Fuse Holders:
 1. Manufacturers:
 - a. Phoenix Contact.
 - b. Rockwell Automation (Allen-Bradley).
 - c. Weidmuller.
 - d. Eaton.
 2. Design and fabrication:
 - a. Modular-type with screw compression clamp.
 - b. Screws: Stainless steel.
 - c. Current bar: Nickel-plated copper alloy.
 - d. Thermoplastic insulation rated for -40 to +105 DEGC.
 - e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
 - f. Blocks can be ganged for multi-pole operation.
 - g. Install end sections and end stops at each end of terminal strip.
 - h. Install machine-printed terminal markers on both sides of block.
 - i. Spacing: 9.1 MM.
 - j. Wire size: 30-12 AWG.
 - k. Rated voltage: 300 V.
 - l. Rated current: 12 A.
 - m. Fuse size: 1/4 x 1-1/4.
 - n. Blown fuse indication.
 - o. DIN rail mounting.
 - p. UL listed.

2.6 POWER SUPPLIES

- A. DC Power Supplies:
 1. Manufacturers:
 - a. Sola Hevi-Duty.
 - b. Phoenix Contact.
 - c. Rockwell Automation.
 2. Design and fabrication:
 - a. Converts 120 VAC input to DC power at required voltage.
 - b. DIN rail mount with enclosure (i.e., not open frame).
 - c. Switching type.
 - d. Provide redundant 24VDC modules with diode redundancy module for automatic switchover to standby module on failure of primary module.
 - e. Hardwire module fault dry contact to associated PLC input for alarm at Plant SCADA.
 - f. AC input: 120 VAC $\pm$ 15 PCT, nominal 60 Hz.
 - g. Efficiency: Minimum 86 PCT.
 - h. Rated mean time between failure (MTBF): 500,000 HRS.
 - i. Voltage regulation:
 - 1) Static: Less than 1.0 PCT V_{out} .
 - 2) Dynamic: $\pm$ 2 PCT V_{out} overall.
 - j. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
 - k. Overload, short circuit and open circuit protection.
 - l. Temperature rating: 0 to 60 DEGC full rated, derated linearly to 50 PCT at 70 DEGC.
 - m. Humidity rating: Up to 90 PCT, non-condensing.
 - n. LED status indication for DC power.
 - o. UL listed.

2.7 VOLTAGE SURGE PROTECTION DEVICES

- A. See Specification Section 26 43 13.

2.8 INTRINSIC SAFETY ISOLATORS

- A. Manufacturers:
 - 1. Phoenix Contact.
 - 2. Pepperl and Fuchs.
 - 3. MTL Instruments Group.
 - 4. R. Stahl.
- B. Design and fabrication:
 - 1. Utilize in all circuits required to be intrinsically safe.
 - 2. All instruments installed in hazardous locations per Section 40 67 00 shall be provided with intrinsic safety isolators.
 - 3. DIN rail mountable.
 - 4. Provide galvanic isolation; use of passive zener diode type barriers is not permitted.
 - 5. Limit voltage and current so that no spark or thermal effect can cause a potentially explosive atmosphere to ignite.
 - 6. Provide redundant 24Vdc power supplies in accordance with Paragraph 2.5 A of this Specification. Power supplies shall be installed in the same enclosure as the intrinsic safety isolators. Power supplies shall be sized based on the active load of the associated loop powered field instruments.
 - 7. Furnish and install in accordance with requirements of NEC Article 504, Intrinsically Safe Systems.
 - 8. Certified to be in accordance with latest edition of UL 913 for application.
 - 9. Operating temperature: 0 to 122 DEGF.

2.9 ALARM BEACONS

- A. Manufacturers:
 - 1. Edwards Signaling.
 - 2. Federal Signal.
- B. Design and fabrication:
 - 1. LED beacons with snap-on high impact polycarbonate base.
 - 2. NEMA 4X enclosure.
 - 3. 120 VAC powered.
 - 4. Beacon shall be suitable for indoor and outdoor installations and shall be panel or conduit mountable.
 - 5. Beacon housing shall be capable of withstanding vibration.
 - 6. Dual-mode design which shall be field adjustable between steady-on OR flashing mode by changing a dipswitch inside the beacon housing.
 - 7. Shatter resistant polycarbonate lens. Lens color shall be Amber.
 - 8. For outdoor locations provide manufacturer supplied gasket kit Edwards Signaling cat. no. GSK-KIT for weatherproofing.
 - 9. For wall mount installations provide manufacturer supplied wall mount bracket Edwards Signaling cat. no. WBR.
 - 10. For panel mount installations provide manufacturer supplied mounting accessories.
 - 11. UL listed.

2.10 HORNS

- A. Manufacturers:
 - 1. Edwards Signaling.
 - 2. Federal Signal.
 - 3. Rockwell Automation (Allen Bradley) - Bulletin 855H High Performance.

- B. Design and fabrication:
 - 1. PLC compatible model.
 - 2. NEMA 4X enclosure.
 - 3. Volume adjustable.
 - 4. Coded or sustained tones.
 - 5. Shall be completely assembled. NO site assembly required.
 - 6. Corrosion resistant finish.
 - 7. Designed for semi-flush panel mount.
 - 8. Manufacturer supplied mounting accessories.
 - 9. Minimum 100 dBa sound at 10 FT.
 - 10. 120 VAC input power.
 - 11. For panel mount installations provide manufacturer supplied mounting accessories.
 - 12. UL listed.

2.11 ALARM DIALER:

- A. General.
 - 1. The system shall receive input from the various monitored items in the form of a change in the status of a dry contact and analog inputs.
 - a. Minimum of 24 monitored digital inputs.
 - b. Minimum of 8 monitored analog inputs.
 - 2. Upon such change, the system shall be capable of automatically dialing up to 8 pre-selected phone numbers.
 - 3. When answered, the system shall send voice messages reporting the specific alarm condition.
 - 4. The system shall also be capable of reporting the status of all monitored items upon receipt of an inquiry phone call.
 - 5. Arrange for and install a dedicated telephone line.
- B. The system shall make provisions for the following input alarms:
 - 1. Upper Site Alarm Dialer:
 - a. Discrete Inputs:
 - 1) Pump House Sump Low Level.
 - 2) Stack Disc Filter System Fault.
 - 3) Circulation Tanks Low Level.
 - 4) Electric Utility Loss of Power.
 - 5) Head Tank Low Level.
 - 6) Recirc Lift Station Fault.
 - 7) UV Disinfection Unit Fault.
 - 8) Diesel Standby Generator Fault.
 - 9) Incubation Head Tanks Low Flow
 - 10) PA Lift Station Fault.
 - 11) Chiller System Fault.
 - 12) ATS in Standby Position.
 - 13) Raceways Low Level.
 - 14) Spare.
 - 15) Spare.
 - 16) Spare.
 - 17) Asphalt Ponds Low Level.
 - 18) Spare.
 - 19) Spare.
 - 20) Spare.
 - 21) Spare.
 - 22) Spare.
 - 23) Spare.
 - 24) Spare.
 - b. Analog Inputs:

- 1) Spare.
- 2) Spare.
- 3) Spare.
- 4) Spare.
- 5) Spare.
- 6) Spare.
- 7) Spare.
- 8) Spare.
2. Lower Site Alarm Dialer:
 - a. Discrete Inputs:
 - 1) Circulation Tanks Low Level.
 - 2) Gas Tower CO2 Blower Fault.
 - 3) Electric Utility Loss of Power.
 - 4) Circulation Tanks Low Dissolved Oxygen.
 - 5) UV Disinfection Unit Fault.
 - 6) Diesel Standby Generator Fault.
 - 7) Supply Lift Station Fault.
 - 8) Drum Filter Fault.
 - 9) ATS in Standby Position.
 - 10) Recirc Lift Station Fault.
 - 11) Concrete Pond Low Level.
 - 12) Intrusion Alarm.
 - 13) PA Lift Station Fault.
 - 14) Spare.
 - 15) Spare.
 - 16) Spare.
 - 17) Spare.
 - 18) Spare.
 - 19) Spare.
 - 20) Spare.
 - 21) Spare.
 - 22) Spare.
 - 23) Spare.
 - 24) Spare.
 - b. Analog Inputs:
 - 1) Dissolved Oxygen Signal 1
 - 2) Dissolved Oxygen Signal 2.
 - 3) Spare.
 - 4) Spare.
 - 5) Spare.
 - 6) Spare.
 - 7) Spare.
 - 8) Spare.
- C. Equipment Description:
 1. The automatic dialer shall be an advanced microprocessor and synthesized voice technology capable of dialing up to eight phone numbers, 16 digits each, maximum.
 2. Phone numbers and standard tone dialing shall be used on standard phone lines.
 3. Surge Protection: Integral gas tube and solid-state protectors on all phone, power, and signal lines.
 4. The unit shall permit the user to program, right from the keyboard, the following functions:
 - a. Each fault channel to a normally open or closed mode.
 - b. A different fault sense delay from 1 to 99 seconds.
 - c. Programmable answering delay of 1 to 20 rings.
 - d. Dialing and re-dialing up to eight separate pre-determined telephone numbers and delivering a synthesized voice message.

5. Normal power shall be 120 VAC, 60 Hz.
 6. The unit shall contain its own rechargeable battery which shall automatically be kept charged when AC power is present.
 7. The system shall operate on battery power for a minimum of 20 HRS in the event of AC power failure.
- D. Enclosure:
1. Interior panel mounting: panel mount
- E. Configuration:
1. Obtain phone numbers, calling sequence, and calling schedule from the Owner and configure the unit with these initial parameters.
- F. Autodialer Manufacturer:
1. Raco Verbatim Series VSS.
 2. Catttron (formerly Antx, Inc.) Dialog Elite.
 3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

END OF SECTION



DIVISION 43

**PROCESS GAS AND LIQUID HANDLING,
PURIFICATION, AND STORAGE EQUIPMENT**



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SECTION 43 21 00
PUMPING EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pumping equipment.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 09 96 00 - High Performance Industrial Coatings.
 - 4. Section 01 61 03 - Equipment - Basic Requirements.
 - 5. Section 43 21 13- Pumping Equipment - Inline and end Suction Centrifugal Pumps
 - 6. Section 43 23 14 - Pumping Equipment - Non-Clog Centrifugal.
 - 7. Section 43 25 13 - Pumping Equipment - Submersible Non-Clog.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ANSI/Hydraulic Institute (ANSI/HI):
 - a. 9.6.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.
 - b. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 - c. 9.6.6, Rotodynamic Pumps for Pump Piping.
 - d. 11.6, Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
 - e. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
- B. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.
- C. Pump/motor and VFD coordination: See Specification Section 01 61 03.

1.3 DEFINITIONS

- A. The abbreviations used in this section are defined as follows:
 - 1. AOR: Allowable Operating Range.
 - 2. BEP: Best Efficiency Point.
 - 3. IPS: Iron Pipe Size.
 - 4. NPSH3: Net Positive Suction Head for 3 PCT head loss.
 - 5. POR: Preferred Operating Range.
 - 6. TDH: Total Dynamic Head.
 - 7. TEFC: Totally Enclosed Fan Cooled.
 - 8. VFD: Variable Frequency Drive.
- B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Specification Section 01 61 03.
 - 3. Product technical data including:

- a. Performance data and curves with flow (GPM), head (FT), horsepower, hydraulic efficiency, rotating speed (RPM), AOR, BEP, POR, NPSH3 requirements, minimum bowl submergence requirements for vertical mixed flow, axial and turbine pumps.
 - b. Pump accessory data.
 - c. Bearing supports, shafting details and lubrication provisions.
 - 1) Bearing life calculations.
 - 2) Critical speed calculations.
 - d. Solids passage information.
- 4. Certifications:
 - a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
 - b. Verification of Primary and Secondary conditions in POR and AOR.
- 5. Test reports:
 - a. Factory hydrostatic test.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
 - 1. Certifications:
 - a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Pumps:
 - a. See individual pump Specification Sections.
 - 2. Mechanical seals:
 - a. Chesterton.
 - b. John Crane.
 - c. Garlock.
 - d. Or as noted in the individual pump Specification Sections.
 - 3. Seal water station:
 - a. Chesterton.
 - b. John Crane.
 - c. AESSEAL.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 CENTRIFUGAL PUMP DESIGN

- A. Provide units with increasing head characteristics from the end run out portion of the curve to:
 - 1. Shut-off condition.
 - 2. For Mixed flow, Axial Flow and Propeller pumps to the right hand edge of the AOR.

2.3 ACCESSORIES

- A. See Specification Section 01 61 03.
- B. Each Unit:
 - 1. Lifting eye bolts or lugs.
 - 2. Plugged gage cock connection at suction and discharge nozzles.
 - 3. Tapped and plugged openings for casing and bearing housing vents and drains.
 - 4. Fittings for properly adding flushing lubricant.

5. Pressure relief fittings for grease lubrication.
- C. Packing Seal:
1. Provide packing unless mechanical seal is specified in narrow-scope pump sections.
 2. Minimum of five rings graphite impregnated synthetic packing.
 3. Provide minimum 1/4 IN DIA supply tap and 1/2 IN DIA minimum drain tap.
 4. Provide split Teflon or bronze water seal ring.
 5. Adjustable split follower cast iron or bronze gland.
- D. Mechanical Seals:
1. Provide as specified in the narrow-scope pump sections.
 2. Provide rotating balanced O-ring type.
 3. Materials:
 - a. Metal parts except springs: 316 stainless steel.
 - b. Springs: Hastelloy C.
 - c. Seal faces: Unfilled carbon graphite versus silica-free Grade 99.5 ceramic.
 - d. Elastomers: Viton.
- E. Seal Water Station:
1. Provide one unit per pump with manual shut-off valve on all pumps with seals.
 2. Features:
 - a. Pressure regulating.
 - b. Flow regulating.
 - c. Cleanable flow tube(s) while in service.
 - d. Hose barb connection.
 - e. Liquid filled pressure gage.
 3. Materials of construction:
 - a. Flowmeter tubes: Polysulfone.
 - b. Unit body: Polyoxymethylene.
 - c. Pressure gage: 316 stainless steel case and wetted parts.
 - d. Pressure regulating valve: 316 stainless steel.
 - e. Flow regulating valve: 316 stainless steel.
 - f. Tube fittings: 316 stainless steel.
 - g. Mounting brackets: 316 stainless steel.
 4. Service:
 - a. Temperatures up to 150 DEGF.
 - b. Pressure up to 140 PSIG.
 5. Connection:
 - a. Hose barb threaded to pump.
 - b. Hose barb to seal water unit.
 - c. Reinforced polyurethane hose:
 - 1) Minimum size: 3/8 IN ID.
 - 2) Minimum pressure rating:
 - a) At 180 DEGF: 115 PSI.
 - b) At 73 DEGF: 200 PSI.
 - 3) Minimum wall thickness: 1/8 IN.
 - d. Non-potable water to shut-off valve: See Section 40 05 00 with isolation ball valve.
 6. Mounting:
 - a. To pump or pipe flange with stainless steel bracket.
 - b. Maximum distance from non-potable water to shut-off ball valve to seal water station and seal water station to pump seal, 2 FT each direction.

2.4 FABRICATION

- A. Pump Support:
1. Design base to support weight of drive, shafting and pump.
 2. Comply with HI vibration limitations.

3. Support non-submersible pumps from walls on brackets with vibration isolation as recommended by pump maker.
4. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
5. Mount vertical pumps on single piece pedestal baseplate.
6. Fabricate to withstand all operating loads transmitted from the pump and drive.
7. On vertically configured end suction centrifugal pumps when supplied with a fabricated steel mounting frame and suction elbow, the suction elbow shall be a long radius reducing elbow with greater than 50 PCT area reduction to comply with Table 9.6.6.3.2 of ANSI/HI 9.6.6 standard for straight pipe lengths.

2.5 SOURCE QUALITY CONTROL

- A. Verification primary design condition in POR.
- B. Verification secondary design condition in AOR.
- C. Factory hydrostatic test all pumps at 150 PCT of shut-off head for a minimum of five minutes.
- D. If specifically required in the individual pump specification sections, provide factory tests:
 1. All units:
 - a. Conduct tests in accordance with HI.
 - 1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per ANSI/HI 14.6 for Rotodynamic Pumps.
 - 2) Shut-off head and design conditions: Positive unilateral performance tolerances meeting Grade 1U per ANSI/HI 11.6 for Rotodynamic Submersible Pumps.
 2. All pumps:
 - a. Head (FT) versus flow (GPM) pump curves:
 - 1) Efficiencies along curve.
 - 2) Brake horsepower along each curve.
 3. Results certified by a registered professional engineer.
- E. Statically and dynamically balance each pump per ANSI/HI standards.
 1. If specifically required in the individual pump specification sections or in Specification Section 01 61 03, field vibration test pumps:
 - a. To meet requirements of ANSI/HI 9.6.4 for Rotodynamic Pumps at any point on the pumps and motor.
- F. To meet requirements of ANSI/HI 11.6 for Submersible Pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 01 61 03.
- B. Floor or Pad-Mounted Units (Non-Submersible):
 1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
 2. Assure no unnecessary stresses are transmitted to equipment flanges.
 3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
 4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
 5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
 6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
 7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
 - a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.

- b. Realign as necessary, install flange bolts and make equipment connection.
- 8. Field paint units as defined in Specification Section 09 96 00.
- 9. Provide pressure gage, visible from grade or operating floor, on discharge of all pumps and on suction and discharge of all non-submersible units.
- C. Submersible Units:
 - 1. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
 - a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
 - b. Realign as necessary, install flange bolts and make equipment connection.
 - 2. Field paint units as defined in Specification Section 09 96 00.
 - 3. Provide discharge pressure gage visible from grade or operating floor.

3.2 FIELD QUALITY CONTROL

- A. Provide services of equipment manufacturer's field service representative(s) to:
 - 1. Inspect equipment covered by this Specification Section.
 - 2. Supervise pre-start adjustments and installation checks.
 - 3. Conduct initial start-up of equipment and perform operational checks.
 - 4. Instruct Owner's personnel for the specified minimum number of hours at jobsite per Specification Section 01 33 04 on operation and maintenance of each of following pumping equipment:

END OF SECTION

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SECTION 43 21 13

PUMPING EQUIPMENT: INLINE AND END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vertical inline centrifugal pumps (CIP-1, CIP-2, EVP-1, and EVP-2)
 - 2. Vertical constant pressure booster single and multi-stage pumps (UTB-1 and UTB-3)
 - 3. Tank Mounted Jet Pump (UTB-2)
 - 4. Close coupled end suction centrifugal pumps (DWP-2)
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 01 - General Requirements.
 - 3. Section 43 21 00 - Pumping Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Bearing Manufacturers Association (ABMA).
 - 2. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 3. Hydraulic Institute (HI):
 - a. Standards for Centrifugal, Rotary and Reciprocating Pumps.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Section 43 21 00.
- B. Operation and Maintenance Manuals:
 - 1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Vertical inline centrifugal pumps (CIP-1, CIP-2, EVP-1, and EVP-2):
 - a. Taco.
 - b. Armstrong.
 - 2. Vertical constant pressure, single and multi-stage pumps (UTB-1 and UTB-3):
 - a. Grundfos
 - 3. Tank Mounted Jet Pump (UTB-2)
 - a. Flint and Walling
 - b. Burcam
- B. Close coupled suction centrifugal pumps (DWP-2):

1. Berkely
2. Goulds
3. Aurora

C. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 VERTICAL INLINE PUMPS (CIP-1, CIP-2, EVP-1, EVP-2)

- A. Split-coupled in-line, single-stage design, for installation in a vertical position motor up, capable of being serviced without disturbing piping connections.
- B. Pump volute shall be of Class 30 cast iron or ductile iron. The impeller shall be of cast iron, enclosed type, balanced to Hydraulic Institute Standards, keyed to the stainless steel shaft and locked. The pump shaft shall be guided by a carbon graphite lower throttle bushing.
- C. Mechanical seal shall include tungsten or silicon carbide and have secondary seal.
- D. Coupling shall allow servicing of the seal without disturbing the pump or motor. The motor bracket shall contain a coupler guard.
- E. Pumps shall be rated for the design conditions indicated on the Drawings, but structurally and mechanically designed for continuous operation at a minimum of 175 psi working pressure and 250°F. The volute shall have gauge tapings at the suction and discharge and vent and drain tapings at the top and bottom.
- F. Motors shall be TEFC NEMA Premium Efficient, or Inverter Duty per Schedule in Drawings, with overload protection.
- G. Each pump shall be hydrostatically tested at the factory per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.3 VERTICAL CONSTANT PRESSURE, VARIABLE SPEED, MULTIPLE STAGE PUMPS (-UTB-3)

- A. Pumps shall be designed for the service conditions indicated on the drawings and be fully packaged systems to include the pumps, variable speed drive and diaphragm tanks. Pumps shall be vertically mounted and where required have multiple stages.
- B. Pumps shall have:
 1. Stainless steel pumping chamber, shaft, and impeller, stainless or iron inlet and outlet, FPT threaded.
 2. have silicon carbide mechanical seals.
 3. TEFC motors with voltage and phase as indicated on the Drawings and provided with integral VFD with overload protection.
 4. Motor mounted programmable VFD with pressure transducer and integral control panel.
 5. Suitable for mounting to wall with shaft vertical and suction inlet pointed down. Factory mounted pressure transducer and diaphragm tank.
 6. Liquid filled 0-200 psi pressure gage.
 7. Program pump to maintain 65 psi discharge.
 8. Pumps shall have suction and discharge connection sizes as indicated on the Drawings.
 9. Pump & tank together shall not be larger than 24" long x 14" across and 8" thick to fit in the space indicated in the Drawings.
 10. Pumps shall be Grundfos CRE series pumps.

2.4 TANK MOUNTED JET PUMP

- A. Pump shall be of a packaged design complete with a pump, 20-gallon diaphragm tank and pressure switch to start and stop the pump. The pump shall be of cast iron or stainless-steel construction, have a capacitor start motor, have NPT connections, and utilize a mechanical seal.

Pump shall provide the service condition and be sized as indicated on the Drawings and be designed for intermittent or continuous operation.

2.5 CLOSE COUPLED, END SUCTION CENTRIFIGAL PUMPS (DWP-2)

- A. Pumps shall be close coupled and utilize mechanical seals and designed for continuous and start stop operations.
- B. Pumps shall have iron volutes, and iron or bronze impellers trimmed to service with wear rings and stainless-steel shafts. Impellers shall be balanced in accordance with HI standards and bearings shall have an ABMA L10 rating of 25,000 hours. The motor shall be single speed, ODP and sized to be non-overloading over the entire pump curve. Motors shall rotate at 3600 rpm, have a 1.15 service factor, and operate on the voltage and phase indicated on the drawings. Pump and motor shall be painted with a 2- part epoxy coating.

2.6 END SUCTION, DUPLEX, CONSTANT PRESSURE, VARIABLE SPEED, MULTIPLE STAGE PUMP STATION (UTB-1)

- A. Pumps shall be designed for the service conditions indicated on the drawings and be fully packaged systems to include the pumps, variable speed drive and diaphragm tanks. Pumps shall have multiple stages.
- B. Pumps shall have:
 - 1. Stainless steel pumping chamber, shaft, and impeller, stainless or iron inlet and outlet, FPT threaded.
 - 2. have silicon carbide mechanical seals.
 - 3. TEFC motors with voltage and phase as indicated on the Drawings and provided with integral VFD with overload protection.
 - 4. Motor mounted programmable VFD with pressure transducer and integral control panel.
 - 5. Suitable for mounting to wall with shaft vertical and suction inlet pointed down. Factory mounted pressure transducer and diaphragm tank.
 - 6. Liquid filled pressure gage.
 - 7. Program pump to maintain 30 psi discharge.
 - 8. Pumps shall have suction and discharge connection sizes as indicated on the Drawings.
 - 9. Pump & tank together shall not be larger than 22" long x 28" across and 22" high to fit in the space indicated in the Drawings.
 - 10. Grundfos CMBE Twin series.

2.7

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Section 43 21 00.

3.2 FIELD QUALITY CONTROL

- A. See Section 43 21 00.

END OF SECTION

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SECTION 43 24 05

PUMPING EQUIPMENT - VERTICALLY SUSPENDED CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vertically suspended centrifugal pumps, also termed "vertical turbine pumps", configured as required in this Section and as shown on the Drawings.
 - a. Two vertical turbine first-stage recirculation pumps.
 - b. Pump control panel.
 - c. Pressure transmitter.
 - d. Level switches (float).
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01 61 03 - Equipment: Basic Requirements.
 - 2. Section 26 29 23 - Variable Frequency Drives – Low Voltage.
 - 3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
 - 4. Section 40 61 13 - Process Control Systems General Requirements.
 - 5. Section 40 61 43 - Surge Protection Devices for Instrumentation and Control Equipment.
 - 6. Section 40 67 00 - Control System Equipment Panels.
 - 7. Section 40 78 00 - Panel mounted instruments.
 - 8. Section 43 21 00 - Pump Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. American Iron and Steel Institute (AISI)
 - a. 1045 Medium Carbon Steel.

1.3 SYSTEM DESCRIPTION

- A. Provide vertical turbine pumps for pumping unfiltered spring water and recirculation water to the circular tank building.
- B. Provide single source coordination responsibility through the pump manufacturer for the entire system including but not limited to the following:
 - 1. Pumps.
 - 2. Motors.
 - 3. Variable Frequency Drives and Controls.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. See Section 40 05 00.
 - 2. Pump control panels:
 - a. Bill of materials.
 - b. Manufacture catalog cut sheets.
 - c. Panel front and interior back panel layout drawings drawn to scale.
 - d. Wiring diagrams.
 - e. Bill of materials.
 - f. Manufacture catalog cut sheets.

- g. Climate control calculations:
 - 1) Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
- h. Control panel electrical load calculations:
 - 1) Total connected load.
 - 2) Peak electrical demand for each panel.
- i. Description of operational control strategy.
- j. Operator interface terminal screens.
- k. PLC ladder logic.
- 3. Pressure transmitter and level switches (float):
 - a. Manufacture catalog cut sheets.
 - b. Manufacturer part numbers.
 - c. Calibrated scale range.
 - d. Tag numbers.
 - e. Installation details.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 33 04 for requirements for Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Goulds.
 - 2. Flygt.
 - 3. Layne-Bowler.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Performance Parameters: Refer to pump schedule on drawings for flow, head, motor, and connection requirements.
- B. Pumps shall be suitable for operation with Variable Frequency Drives.
- C. Provide pumps with increasing head characteristics from secondary design conditions to primary design condition. Provide pumps with net positive suction head requirements (NPSHR) less than the net positive suction head available (NPSHA) at all operating conditions.

2.3 COMPONENTS

- A. General:
 - 1. Furnish units consisting of a vertical shaft turbine, direct connected to a vertical hollow shaft motor. Design unit with non-reversing ratchets.
 - 2. Weight of revolving parts of pump including unbalanced hydraulic thrust of impeller is carried by thrust bearing in driver.
 - 3. Make provision at driver shaft for adjusting impeller with reference to bowls.
- B. Column:
 - 1. Construct discharge column pipe of steel and supply with threaded connections.
 - 2. Provide top and bottom sections of column pipes to 5 FT lengths.
 - 3. Provide intermediate column sections not exceeding 10 FT in length.
 - 4. Abrasive blast column and coat with a minimum 15 mils dry film thickness epoxy system at the factory.
 - 5. Provide coating recommended by Tnemec or Koppers and approved for use with potable water.

- C. Open Line Shaft:
1. 416 stainless steel, rolled and ground.
 2. Maximum length: 10 FT.
 3. Furnish renewable shaft sleeves constructed from 416 stainless steel at each bearing location.
 4. Undercutting of shafting at sleeve locations is not permitted.
 5. Provide rubber bearings at each column connection supported by retainers butted between machined faces of discharge column.
 6. Provide line shaft pre-lubrication system to water lubricate line shaft bearings prior to pump startup.
- D. Pump Bowl and Suction Bell:
1. Provide bowl and suction bell constructed of close-grained cast iron, free from imperfections and accurately machined and fitted.
 2. Coat pump bowl water passages with an abrasion-resistant baked enamel, phenolic or epoxy.
 3. Provide coating suitable for potable water service.
 4. Design to ensure easy removal of bearings and impeller.
 5. Furnish suction bell with flared end to reduce entrance losses and with a sufficient number of vanes to support lower guide bearings and weight of impeller and pump shaft when dismantling pump.
- E. Bearings:
1. Provide units with sleeve bearings of SAE 1618 bismuth bronze in each bowl and in suction bell.
 2. In bowl, provide main bronze bearing immediately above impeller and a lower bronze bearing immediately below impeller.
 3. Provide for lubrication of bowl bearings with pumped liquid.
 4. Furnish suction bell bearing having minimum length equal to five shaft diameters.
 5. Ensure bell bearing is permanently packed type with packing to be a non-soluble grease.
 6. Provide SAE 1618 bismuth bronze collar for bell bearing to prevent abrasives from entering bearing.
- F. Column Adapter:
1. Provide cast iron column adapter with two by-pass port openings to drain leakage into sump.
 2. Furnish two lip seals below the enclosed line shaft bearing to prevent entrance of liquid and suspended matter.
- G. Pump Shaft and Impeller:
1. Provide pump unit shaft constructed of rolled and ground 416 or 410 stainless steel.
 2. Furnish enclosed type impellers constructed of bronze and securely attached to impeller shaft.
 3. Ensure impeller is accurately fitted and statically and dynamically balanced.
 4. Provide cast iron replacement wear rings in each bowl to prevent wear on bowls.
- H. Discharge Head Assemblies:
1. Cast - surface discharge head: This type is standard on all short-coupled and well type pumps with discharge size up to and including 12 IN.
 2. Design discharge head assembly for 150 PSI working pressure and 250 PSI test pressure.
 3. Provide discharge head for above ground mounting constructed of close-grained cast iron with integral discharge flange.
 4. Construct discharge nozzle with a vertical vane to minimize turbulence.
 5. Furnish ASME B16.1, 125/150 LB flange.
 6. Mount discharge head on fabricated steel base plate which is of sufficient size to span opening in support structure.
 7. Supply base plate with lifting lugs capable of supporting weight of entire unit.
 8. Weld flange to column pipe at specified elevation.

9. Mount discharge head on fabricated steel base plate.
 10. Ensure baseplate is of sufficient size to span opening in support structure.
 11. Supply base plate with lifting lugs capable of supporting weight of entire unit.
 12. Furnish stuffing box constructed of cast iron and containing not less than four rings of non-asbestos packing. Compress packing around shaft with adjustable gland. Furnish grease fitting to provide additional lubrication to bronze upper shaft bearing. Provide connections for grease inlet and pressure relief. Provide 416 stainless steel shaft at top section of line shaft where it passes through stuffing box. Provide bronze upper shaft bearing directly below stuffing box, in the head, to eliminate any shaft whip which could damage the seal. Hard pipe stuffing box bleed-off to wet pit below pumps.
- I. Suction Strainer:
1. Supply basket type strainer constructed of stainless steel with net open area of not less than four times the throat area of the suction bell.
 2. Maximum opening shall not be more than 75% of the minimum opening of the water passage through the bowls and impellers.
- J. Data Plates:
1. Provide stainless steel data plate securely attached to pump.
 2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.
- K. Motors:
1. Inverter duty rated, vertical hollow shaft, squirrel cage, induction type.
 2. 460 V, 60 HZ, 3 PH.
 3. WP-1 with 1.15 service factor.
 4. Size motor to drive pump continuously over the complete head - capacity range without the load exceeding the nameplate rating.
 5. Insulated drive end bearing.
 6. Shaft grounding ring:
 - a. Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
 - b. Electro Static Technology AEGIS SGR Bearing Protection Ring, or approved equal.
 7. Motor thermal protection requirements: winding temperature switches.
 8. Motor space heater for condensation protection.
 9. Design motor for 40 DEGC ambient.
 10. Comply with Section 01 61 03.

2.4 ACCESSORIES

- A. See Sections 01 61 03, 43 21 00, and Section 40 61 13.
- B. Controls:
1. Provide Controls for the pumps at 15- LS02. The controls shall provide the following pump operation:
 - a. Only one pump will be in operation at a time, the secondary pump will act as backup should the lead pump fail.
 - b. Pump speed will automatically adjust to maintain pressure downstream of 25' of head. Pump will operate in this mode without stopping and starting. The flow varies from 600 to 1600 gpm, and frequencies will automatically adjust to meet the pressure and flow demands.
 - 1) The pump speed shall be automatically controlled using PID loop control to maintain an operator adjustable pressure setpoint.
 - c. Alarms shall remain active until acknowledged by the operator.
 - d. A Variable Frequency Drive (VFD) with manual and automatic operation isolation bypass.
 - 1) The controls shall allow manual adjustment of pump speed .

- 2) Upon VFD failure the pump will shut down and the backup pump will automatically start and operate to maintain the pressure setpoint.
- e. A pressure transducer downstream of the pump discharged will be used to measure pressure within the system
- f. Two (2) floats are used to actuate the following alarms for the pump:
 - 1) Low-low:
 - a) If flow to the lift station is obstructed the water level in the sump may draw down. A float switch shall be provided to shut the pump down and actuate an alarm (low-low level) if the level in the sump is drawn down to 0.5 feet above the minimum submergence level of the pump line shaft.
 - 2) Low:
 - a) A second float switch shall be provided at a level 2 feet above the minimum submergence level of the pump. This float switch will actuate an alarm (low level) if the water level in the sump is drawn down to the float level but will not stop the pump.

C. Pump Control Panels:

1. Furnish and install locally mounted automatic control panel at location shown on Drawings.
 - a. The control panel shall be located outdoors and shall be designed with environmental controls.
2. Enclosed motor controllers and motor protector panel.
3. Stainless steel enclosure with NEMA 4X rating:
 - a. Continuous seam welded.
 - b. Single front door with continuous hinge, neoprene gasket.
 - c. Mechanism designed for securing enclosure with padlock.
 - d. Mounted on a support frame, pedestal mounting.
 - e. Inner door in cabinet mounted on a continuous vertical steel hinge; size to completely cover wiring and components mounted on the back panel; provide for mounting of controls and instruments on inner door.
4. Incoming power: 480 VAC, 3-phase.
 - a. Main circuit breaker with external circuit breaker operating handle.
 - b. Handle shall include locking tabs that prevent the door from being opened with the breaker in the ON position.
 - c. Transient Voltage Surge Suppression (TVSS):
 - 1) UL 1449 listed.
5. Variable frequency drives (VFDs) with isolation bypass.
 - a. The HMI (human-machine interface) for the VFDs shall be installed on the inner door.
6. Programmable Logic Controller (PLC).
7. Control transformer with line and load fuses.
8. Operator Interface Terminal (OIT).
 - a. Color graphical panel with touch screen or button interface.
 - b. Discharge flow rate indication.
 - c. Discharge pressure indication.
 - d. Operator adjustable pressure setpoint.
 - e. Operator adjustable PID loop parameters.
 - f. Operator adjustable discharge pressure alarm thresholds.
 - 1) The PLC shall generate an alarm if the discharge pressure is below the adjustable threshold for an operator adjustable time delay (initially set to 15 seconds).
9. Low level alarm with silence and alarm light.
10. Alarm reset pushbutton.
11. Power ON indication light
12. Pilot devices, indication, and dials for each pump:
 - a. Running status.
 - b. Off status.
 - c. Fault indication.
 - d. Hand-Off-Automatic (HOA) selector switches.

- e. Dial type speed adjustment knob.
 - f. Elapsed time meter.
- 13. Space heater, enclosure air conditioner, and thermostats.
- 14. Utility light, LED.
- 15. Alarm outputs shall be provided in the form of dry SPDT relay contacts wired to terminal blocks:
 - a. Pump 1 fault.
 - b. Pump 2 fault.
 - c. Low level alarm.
 - d. Low pressure alarm.
 - e. Common alarm:
 - 1) The alarms listed above shall be grouped into a common alarm.
- 16. Provide power for the motor space heaters.
- 17. Provide power for the discharge flowmeter.
 - a. Reference specification 40 71 00.
- 18. Include a terminal board for connection to level switches, pressure transmitter, and flow meter.
- 19. Fabrication requirements:
 - a. All internal wiring shall be neat and color coded. Each wire shall be labeled at both ends with a heat-shrinkable wire label. All incoming wires shall terminate into a box clamp type terminal block. All control wires shall be 14 Ga. Type TEW, tinned copper, rated for 105 DegC.
 - b. A schematic diagram (showing wire color) shall be permanently fastened to the inside of the enclosure. An Installation and Service Manual shall also be included with each control panel.
 - c. Apply corrosion inhibitors inside the panel after fabrication and prior to shipment to the jobsite. Inhibitor shall consist of agents that vaporize and then condenses on all internal surfaces of the enclosure.
 - d. Panel shall be factory wired and tested.
 - e. The control panel shall be U.L. listed as an assembly.
 - f. Pilot devices:
 - 1) Heavy-duty type.
 - 2) Oiltight, NEMA 4X rating.
 - 3) Mounting hole: 30.5mm.
 - 4) Knob type operators.
 - 5) Push-to-test pilot lights, lens color as indicated.
 - 6) Legend plates:
 - a) Laminated, phenolic plastic with white field and black letters.
 - b) Size: 2 IN x 2 IN.
- D. Access Doors and Frames for Wet Pit Applications:
 - 1. Doors: See Specification Section 08 31 00.
- E. Pressure Transmitter:
 - 1. Schedule:
 - a. Tag Number: 15-PT01.
 - 2. Manufacturers:
 - a. Emerson Rosemount (3051).
 - b. Endress + Hauser (Cerabar S).
 - c. Honeywell (ST 3000 Series 100).
 - d. Schneider Electric / Foxboro (IGP/IAP).
 - e. Siemens (SISTRANS P500).
 - 3. Materials:
 - a. Process flanges and adapters: 316 stainless steel.
 - b. Vent/drain valve: 316 stainless steel.
 - c. Isolating diaphragm: 316 stainless steel.

- d. Housing: Aluminum.
- e. Fill fluid: Manufacturer's standard.
- 4. Design and fabrication:
 - a. Smart transmitters utilizing microprocessor-based electronics.
 - b. Signal Output: 4-20 mA DC proportional to pressure with HART communications.
 - c. Nonvolatile EEPROM memory.
 - d. Power supply: 24 VDC loop power (2-wire).
 - e. Digital display.
 - f. Adjustable zero and span.
 - g. Temperature limits: -4 to 175 DEGF
 - h. Overpressure limits: Withstand 150 percent of stated maximum service pressure without damage.
 - i. Humidity limits: 0 to 100 percent relative humidity.
 - j. Damping: Adjustable between 0 and 60 seconds.
 - k. Accuracy (includes effects of linearity, repeatability and hysteresis): ± 0.10 percent of calibrated span for 15:1 rangeability.
 - l. Stability: ± 0.2 percent of upper range limit for 12 months.
 - m. Temperature effect:
 - 1) Total effect including span and zero errors: + 0.2% of upper range limit per 100 DEGF for minimum 15:1 rangeability.
 - n. Minimum 1/2 IN pressure connection.
 - o. Equip with test jacks or accessible terminals for testing output.
 - p. Equip with isolation valve and test connections with isolation valves and/or plugs.
- F. Level Switches (Float):
 - 1. Schedule:
 - a. Tag Numbers: 15-LSL01, 15-LSLL01.
 - 2. Manufacturers:
 - a. Anchor Scientific Inc.
 - b. Consolidated Electric.
 - c. Contegra.
 - 3. Materials:
 - a. Float material: Polypropylene or Teflon coated type 316 stainless steel.
 - b. Cable jacket: PVC, neoprene.
 - c. Cable clamp: Polypropylene or 316 stainless steel.
 - 4. Design and fabrication:
 - a. Mercury-free switch.
 - b. Provide switch complete with flexible electrical cables.
 - c. DPST contact rated at 1 amp at 120 VAC.
 - d. Direct acting float switch:
 - 1) Switch actuates on rising level.
 - 2) Switch deactuates when liquid falls 1 IN below actuation level.
 - e. Terminate cables in junction box.
 - f. Process temperature: max. 120 DEGF.
 - g. Install floats per drawing details.

2.5 MAINTENANCE MATERIALS

- A. Extra Materials:
 - 1. Furnish the Owner the following extra parts for each pump service category:
 - a. Lower bearing assembly: One set.
 - b. Upper bowl bearing: One set.
 - c. Line shaft bearing assemblies: One set.
 - d. Packing, gland follower, studs and nuts: One set.
 - e. Lantern ring: One.
 - f. Wearing rings: One set.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

- A. See Section 43 21 00.

END OF SECTION

SECTION 43 25 13
PUMPING EQUIPMENT - SUBMERSIBLE END-SUCTION PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Submersible pumps in a wet pit application for pumping of unscreened water.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 08 31 00 - Access Doors.
 - 4. Section 09 96 00 - High Performance Industrial Coatings.
 - 5. Section 26 05 00 - Electrical - Basic Requirements.
 - 6. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
 - 7. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
 - 8. Section 26 24 19 - Motor Control Equipment.
 - 9. Section 40 61 13 - Process Control Systems General Requirements.
 - 10. Section 40 61 43 - Surge Protection Devices for Instrumentation and Control Equipment.
 - 11. Section 40 67 00 - Control System Equipment Panels.
 - 12. Section 40 78 00 - Panel mounted instruments.
 - 13. Section 43 21 00 - Pumping Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Bearing Manufacturers Association (ABMA).
 - 2. American National Standards Institute (ANSI).
 - 3. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - 4. FM Global (FM).
 - 5. Hydraulic Institute (HI):
 - a. Standards for Centrifugal, Rotary and Reciprocating Pumps.
 - 6. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 7. National Fire Protection Agency (NFPA):
 - a. 70, National Electrical Code (NEC):
 - 1) Article 500, Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2.
 - 8. Underwriters Laboratories, Inc. (UL).
 - a. 62, Flexible Cord and Fixture Wire.

1.3 SYSTEM DESCRIPTION

- A. Provide submersible pumps for pumping unfiltered water and recirculation water to the hatchery.
- B. Provide single source coordination responsibility through the pump manufacturer for the entire system including but not limited to the following:
 - 1. Pumps.
 - 2. Motors.
 - 3. Variable Frequency Drives and Controls.

1.4 SUBMITTALS

- A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Requirements in Specification Section 01 61 03.
 3. Requirements in Specification Section 43 21 00.
 4. Pump control panels:
 - a. Bill of materials.
 - b. Manufacture catalog cut sheets.
 - c. Panel front and interior back panel layout drawings drawn to scale.
 - d. Wiring diagrams.
 - e. Bill of materials.
 - f. Manufacture catalog cut sheets.
 - g. Climate control calculations:
 - 1) Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
 - h. Control panel electrical load calculations:
 - 1) Total connected load.
 - 2) Peak electrical demand for each panel.
 - i. Description of operational control strategy.
 5. Level switches (float):
 - a. Manufacture catalog cut sheets.
 - b. Manufacturer part numbers.
 - c. Installation details.
- B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 04 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content of Operation and Maintenance Manuals.
- C. Project Information:
1. Executed Manufacturer's Installation Certification Form.

1.5 SHIPPING

- A. Per Section 01 61 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Flygt.
 2. Grundfos.
 3. Sulzer – ABS.
- B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Refer to Pump Schedule on Drawings for flow, head, motor and connection requirements
- B. Pumps shall be suitable for operation with Variable Frequency Drives

2.3 MATERIALS

- A. All Pumps:
1. Pump case: Cast iron, ASTM A48, Class 35.
 2. Motor housing: Cast iron, ASTM A48, Class 25 or Class 30.
 3. Impeller: Cast Iron, ASTM A-532 Class III, Type A or Cast iron, ASTM A48, Class 30.
 4. Shaft: Stainless Steel, Series 300 or 400.

5. Suction cover: Cast Iron, ASTM A-532 Class III, Type A.
6. O-rings: Nitrile (Buna-N) or fluorocarbon (Viton).
7. Fasteners: Stainless steel.
8. Lower ring seal: Tungsten-carbide both faces or Silicon Carbide both faces.
9. Upper ring seal: Tungsten-carbide both faces or carbon and ceramic or carbon and Ni-resist.
10. Seal metal parts: Stainless steel.

2.4 COMPONENTS

A. General:

1. Provide pumps capable of handling unscreened water.
2. Where watertight sealing is required, machine and fit mating surfaces with O-rings.
3. Provide with heavy duty lift lugs or hoisting bail designed for lifting the entire pump and motor assembly.

B. Impeller:

1. Provide semi-open solids-handling type dynamically balanced impeller in accordance with HI standards.
2. Provide adjustable impeller that will provide effective sealing between the suction cover and impeller

C. Shaft:

1. Design shaft for a maximum deflection of 0.004 IN at the stuffing box as calculated at the design condition.

D. Mechanical Seal:

1. Seal shaft with double mechanical seal running in an oil filled chamber.
2. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
3. Hold interface in contact by its own spring system.

E. Bearings:

1. Support shaft on upper and lower permanently lubricated bearings with a minimum ABMA L-10 life of 100,000 HRS.

F. Motors:

1. Provide pump with FM, UL, or CSA listed motor approved for area classification shown on Drawings.
2. Provide induction type motor with a squirrel cage rotor, of totally submersible design without loss of watertight integrity to a depth of at least 65 FT, constructed with epoxy or poly-seal encapsulated windings, air-filled or dielectric oil filled, with Class H insulation rated for 180 DEGC and rated for continuous duty operation.
3. Motor shall be 3PH, 60 cycle, 460 V.
4. Motor shall be capable of running continuously in an unsubmerged condition while pumping under load without damage to motor or seal.
5. The motor horsepower provided shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through runout.
6. The motor shall be designed and assembled by the same manufacturer as the pump.
7. The motor shall be equipped with a closed loop cooling system where the cooling medium is circulated through the pump motor cooling jacket. The pumped fluid shall not be circulated through the cooling jacket. An impeller in the lower motor coolant reservoir will circulate coolant around the motor housing. The cooling system shall provide sufficient cooling for continuous operation whether the pump is submerged in the pumped media or surrounded by air in liquid or ambient temperatures of up to 40 DEGC.
8. Cooling system will provide sufficient cooling for the entire range of pump operating speeds.

G. Power and Control Cables:

1. Provide power and control cables which are listed per NEC requirements and approved for the installation types indicated on the drawings. As a minimum the cable shall be suitable for installation in conduit and for submersible applications.
 2. Size cables in accordance with applicable NFPA 70 specifications.
 3. Provide 50FT power cable and control cable.
 4. Provide each cable with a strain relief, cord grip, and explosion proof seal installed in accordance with NFPA 70, Article 500.
 5. Minimum acceptable cable type: "SO-Water Resistant" per UL 62.
- H. Temperature Monitor:
1. Furnish each phase of the motor with thermal switches embedded in the motor windings.
 2. Should high temperature be sensed in the windings, the thermal switch will open, shut the pump down, and sound an alarm. Should any one of the thermal switches detect high temperature, it will automatically reset once the stator temperature returns to normal.
 3. Set temperature of the temperature monitors not higher than 90 PCT of insulation temperature rating.
- I. Leak Detection:
1. Provide sensors inside the terminal board and the stator chamber to detect water intrusion
 2. If water is detected inside the terminal board or the stator chamber, a switch will stop the pump and sound an alarm.
- J. Coatings:
1. Apply two-component oxirane ester or polyamidoamine epoxy system to the exterior of the pump casing and motor housing as specified in Specification Section 09 96 00.
- K. Wet Pit Applications:
1. Provide sliding guide bracket integral to pump unit which properly aligns the pump discharge with the discharge connection elbow for watertight seal during pumping.
 2. Guide the entire weight of the pumping unit to the base discharge elbow by guide rail(s).
 3. The guide rail(s) shall not support any portion of the weight of the pump.
 4. Provide chains or cable of sufficient strength to lift pumps from sump.
 5. Furnish guiding rail assembly and the discharge flange assembly of non-sparking components.
 6. Design pump to allow for removal without entering the wet well and without removal of bolts, nuts or other fastenings.
 7. Provide pump unit connecting to discharge connection with a simple downward motion without rotation. The entire weight of the pumping unit shall wedge tightly against the discharge elbow flange forming a seal without the use of bolts, gaskets, or O-rings.
 8. Provide necessary sliding guide bracket and discharge connection which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.
 9. No portion of the pump shall bear directly on the floor.
- L. Dry Pit Applications:
1. Provide suction elbow with integral handhole and rubber gasketed cover.
 - a. Provide handhole cover with surfaces to match the internal contours of the suction elbow.
 - b. Provide with ANSI 125 LB flat face flange for connection to suction piping.
 - c. 1-1/2 IN tapped connection.
 - d. Suction elbow must be long-radius and have greater than 50 PCT area reduction from the inlet to the outlet of the elbow.
 2. Provide a fabricated heavy duty support stand designed for the pump furnished. Provide stand with openings sized to allow access to the suction elbow for dismantling, easy access to the hand hole cover and its fastening hardware, and access to any tapped connections into the suction elbow.
 3. Provide ANSI 125 LB pump suction and discharge flanges.

2.5 ACCESSORIES

- A. See Specification Section 43 21 00 - Pumping Equipment: Basic Requirements.
- B. Controls:
 - 1. Provide Controls for the pump at 08-LS01. The controls shall provide the following pump operation:
 - a. Allow the pump speed to be adjusted manually. Normally the pump will operate at the adjusted speed without stopping and starting. The flow varies from 450 to 700 gpm, and pump speed will be manually adjusted to meet the flow demands.
 - b. Alarms shall remain active until acknowledged by the operator.
 - c. A manually operated Variable Frequency Drive with isolation bypass. The controls shall allow manual adjustment of pump speed and if the drive fails, the pump will shut down.
 - d. Three (3) floats are used to actuate the following alarms for the pump:
 - 1) Low-low:
 - a) If the pump speed is not adjusted correctly the water level in the sump may draw down. A float switch shall be provided to shut the pump down and actuate an alarm (low –low level) if the level in the sump is drawn down to 0.5 feet above the minimum submergence level of the pump.
 - 2) Low:
 - a) A second float switch shall be provided at a level 2 feet above the minimum submergence level of the pump. This float switch will actuate an alarm (low level) if the water level in the sump is drawn down to the float level but will not stop the pump.
 - 3) High:
 - a) A third float switch shall be provided that will actuate an alarm (high level) when the water level reaches two feet below the top of the manhole.
 - e. Each float shall:
 - 1) Seal mercury tube switches in a solid polypropylene float.
 - 2) Provide float with large radius top at electrical cable connection to assure trouble-free operation.
 - 3) Suspend floats on their own cable.
 - 4) Provide floats to operate at the elevation shown on Drawings.
 - 5) Design floats to be field-adjustable.
 - 6) Provide an intrinsically safe relay for each level control circuit to reduce the energy in the circuit to the point that no spark is created by switching.
 - 2. Provide Controls for the pumps at 15-LS01. The controls shall provide the following pump operation:
 - a. Only one pump will be in operation at a time and the subsequent pump will act as backup should the lead pump fail.
 - b. Allow the pump speed to be adjusted manually. In normal operation the pumps will operate at the adjusted speed without stopping and starting. The flow demand varies from 400 gpm to 1,600 gpm, and pump speeds will be manually adjusted to meet the flow demands.
 - c. Alarms shall remain active until acknowledged by the operator
 - d. A manually operated Variable Frequency Drive with isolation bypass. The controls shall allow manual adjustment of pump speed and if the drive fails, the pump will shut down.
 - e. Three (3) floats are used to actuate the following alarms for the pump:
 - 1) Low-low:
 - a) If the pump speed is not adjusted correctly the water level in the sump may draw down. A float switch shall be provided to shut the pumps down and actuate an alarm (low–low level) if the level in the sump is drawn down to 0.5 feet above the minimum submergence level of the pump.
 - 2) Low:

- a) A second float switch shall be provided at a level 2 feet above the minimum submergence level of the pump. This float switch will actuate an alarm (low level) if the water level in the sump is drawn down to the float level but will not stop the pump.
 - 3) High:
 - a) A third float switch shall be provided that will actuate an alarm (high level) when the water level reaches 78.50'.
 - f. Each float shall:
 - 1) Seal mercury tube switches in a solid polypropylene float.
 - 2) Provide float with large radius top at electrical cable connection to assure trouble-free operation.
 - 3) Suspend floats on their own cable.
 - 4) Provide floats to operate at the elevation shown on Drawings.
 - 5) Design floats to be field-adjustable.
 - 6) Provide an intrinsically safe relay for each level control circuit to reduce the energy in the circuit to the point that no spark is created by switching.
3. Provide Controls for the pumps at both Pollution Abatement Pond Lift Stations. The controls shall provide the following pump operation:
- a. In normal operation the pumps turn on when the water surface in the manhole reached the pump on float and will remain on until the water surface within the manhole drops to the pump off float elevation. The flow demand for the pump is 200 gpm at 20 TDH; pump is not VFD controlled.
 - b. Alarms shall remain active until acknowledged by the operator
 - c. The controls shall allow manual on/off operation of pump.
 - d. Three (3) floats are used to actuate the following operation and alarms for the pump:
 - 1) Pump On:
 - a) If the water surface in the manhole reached the pump on float, this shall signal the pump to start. See drawings for elevations. A run light will indicate that the pump is running.
 - 2) Pump Off:
 - a) Once the manhole is pumped down and the pump off float is reached, this shall signal the pump to turn off. See drawings for elevations. The run light will turn off.
 - 3) High:
 - a) A third float switch shall be provided that will actuate an alarm (high level) when the water level reaches the elevation indicated on the drawings.
 - e. Each float shall:
 - 1) Seal mercury tube switches in a solid polypropylene float.
 - 2) Provide float with large radius top at electrical cable connection to assure trouble-free operation.
 - 3) Suspend floats on their own cable.
 - 4) Provide floats to operate at the elevation shown on Drawings.
 - 5) Design floats to be field-adjustable.
 - 6) Provide an intrinsically safe relay for each level control circuit to reduce the energy in the circuit to the point that no spark is created by switching.

C. Control Panels:

- 1. Furnish and install locally mounted automatic control panel for each pump station at location shown on Drawings.
 - a. The control panel shall be located outdoors and shall be designed with environmental controls.
- 2. Enclosed motor controllers and motor protector panel.
- 3. Stainless steel enclosure with NEMA 4X rating:

- a. Continuous seam welded.
 - b. Single front door with continuous hinge, neoprene gasket.
 - c. Mechanism designed for securing enclosure with padlock.
 - d. Mounted on a support frame, pedestal mounting.
 - e. Inner door in cabinet mounted on a continuous vertical steel hinge; size to completely cover wiring and components mounted on the back panel; provide for mounting of controls and instruments on inner door.
4. Incoming power: 480 VAC, 3-phase.
 - a. Main circuit breaker with external circuit breaker operating handle.
 - b. Handle shall include locking tabs that prevent the door from being opened with the breaker in the ON position.
 - c. Transient Voltage Surge Suppression (TVSS):
 - 1) UL 1449 listed.
 5. Variable frequency drives (VFDs) with isolation bypass.
 - a. The HMI (human-machine interface) for the VFDs shall be installed on the inner door.
 6. Control transformer with line and load fuses.
 7. Moisture and temperature sensing relays for each pump.
 - a. Shall be fully compatible with the moisture and temperature sensors embedded in the pump/motor.
 8. Low level alarm with silence and alarm light.
 9. High level alarm with silence and alarm light.
 10. Alarm reset pushbutton.
 11. Power ON indication light.
 12. Pilot devices, indication, and dials for each pump:
 - a. Running status.
 - b. Off status.
 - c. Fault indication.
 - d. Hand-Off-Automatic (HOA) selector switches.
 - e. Dial type speed adjustment knob.
 - f. Elapsed time meter.
 13. Space heater, enclosure air conditioner, and thermostats.
 14. Utility light, LED.
 15. Alarm outputs shall be provided in the form of dry SPDT relay contacts wired to terminal blocks:
 - a. Fault for each pump.
 - b. Low level alarm.
 - c. High level alarm.
 - d. Common alarm:
 - 1) The alarms listed above shall be grouped into a common alarm.
 16. Include a terminal board for connection to level switches.
 17. Fabrication requirements:
 - a. All internal wiring shall be neat and color coded. Each wire shall be labeled at both ends with a heat-shrinkable wire label. All incoming wires shall terminate into a box clamp type terminal block. All control wires shall be 14 Ga. Type TEW, tinned copper, rated for 105 DegC.
 - b. A schematic diagram (showing wire color) shall be permanently fastened to the inside of the enclosure. An Installation and Service Manual shall also be included with each control panel.
 - c. Apply corrosion inhibitors inside the panel after fabrication and prior to shipment to the jobsite. Inhibitor shall consist of agents that vaporize and then condenses on all internal surfaces of the enclosure.
 - d. Panel shall be factory wired and tested.
 - e. The control panel shall be U.L. listed as an assembly.
 - f. Pilot devices:
 - 1) Heavy-duty type.
 - 2) Oiltight, NEMA 4X rating.

- 3) Mounting hole: 30.5mm.
- 4) Knob type operators.
- 5) Push-to-test pilot lights, lens color as indicated.
- 6) Legend plates:
 - a) Laminated, phenolic plastic with white field and black letters.
 - b) Size: 2 IN x 2 IN.

D. Access Doors and Frames for Wet Pit Applications:

1. Doors: See Specification Section 08 31 00.

2.6 SOURCE QUALITY CONTROL

- A. Secure from the pump manufacturer the following inspections and tests on each pump before shipment from factory:
 1. Check impeller, motor rating and electrical connections for compliance with this Specification Section.
 2. Test motor and cable insulation for moisture content or insulation defects.
 3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
 4. Run pump submerged for 30 minutes.
 5. After operational test #4, perform insulation test (#2) again.
- B. Factory test of head (FT) versus flow (GPM) for all pumps being provided as specified in Specification Section 43 21 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 43 21 00.
- B. For wet pit pumps, permanently install discharge connection elbow in wet well along with discharge piping.
- C. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.2 FIELD QUALITY CONTROL

- A. See Specification Section 43 21 00.

END OF SECTION



DIVISION 46

WATER AND WASTEWATER EQUIPMENT



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SECTION 46 71 33
ROTARY DRUM SLUDGE THICKENING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rotary drum filters with effluent level control pan and with backwash systems with strainers, valves, gages, pumps and hoses.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 01 61 03 - Equipment - General Requirements.
 - 4. Section 05 50 00 - Metal Fabrications.
 - 5. Division 26 - Electrical.
 - 6. Section 40 05 66 - Check Valves.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 2. American Welding Society (AWS).
 - 3. Hydraulic Institute (HI).
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. Single Source Responsibility:
 - 1. All equipment described in this Specification shall be supplied by the thickener manufacturer.
 - 2. The thickener manufacturer shall be fully responsible for the design of the equipment and integration of all system components to meet all design and performance requirements specified herein.
 - 3. Coordinate placement of manually operated equipment and appurtenances to locations easily accessible to operator following installation of all systems and equipment included in this Contract.
 - a. Manually operated equipment and appurtenances include but are not limited to valves, reservoirs, grease fittings and other lubricating devices, handwheels for wash tube assemblies, and electrical control devices.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. See Section 01 61 03.
 - 3. Certification of compatibility of all variable speed drives with motors provided.
 - 4. Utility utilization rates and pressures.
 - 5. Provide complete manufacturer's installation instructions, construction details, materials of construction, electrical diagrams, and motor and drive details.
 - 6. Provide complete layout drawings showing locations of ancillary equipment, foundation requirements and supporting calculations, utility connections, location of thickener relative to equipment pad and discharge end enclosure.
 - 7. Certification of bearing life.

8. Screen specifications including type and mesh size or opening size.
 9. Documentation necessary to verify that thickening unit complies with specified construction.
 10. Performance test protocol.
 11. Provide complete layout drawings for discharge end enclosure.
 12. Local control panel data sheets.
 - a. Catalog sheet on all components.
 - b. Wiring diagrams.
 - c. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.
- B. Contract Closeout Information:
1. Operation and Maintenance Data:
 - a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
- C. Informational Submittals:
1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. Manufacturer's certification of installation and start-up.
 3. Performance test report:
 - a. Performance test report shall have at minimum the following:
 - 1) Summary of testing details.
 - 2) Testing results.
 - 3) Comparison of test results to minimum performance requirements.
 - 4) Presentation of data and results in graphical form.
 4. Qualifications of welders.
 5. List of past projects of similar scope and size.

1.4 PERFORMANCE WARRANTY

- A. The thickener manufacturer shall guarantee the performance of the thickening system supplied based on minimum performance requirements described in this Specification.
- B. If the thickener does not meet the minimum performance requirements described in this Specification, the Owner, at his discretion, shall assess a monetary penalty of 100 PCT of the equipment cost for the thickener systems supplied.
- C. A retainage equal to 20 PCT of the equipment cost will be withheld by the Owner until after the performance testing.
1. If the thickener meets the minimum performance requirements, the Owner will then pay the amount retained on the general contractor's next partial payment request after successful performance testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. NP Innovations AB
 2. HydroTech

2.2 ROTATING DRUM FILTER

A. General

1. Drum filter mounting and installation dimensions and elevations were designed around the NP Innovations F1215-L drumfilter. Alternate equipment is acceptable providing the equipment is designed to operate as specified in section 2.1.B and the critical components are accepted as equivalent by the Owner. In addition, if alternate equipment is to be provided, it is the Contractors responsibility to verify and adjust as needed to all affected dimensions, elevations, and structural support systems to provide operation of the complete system equivalent to the original design. All adjustments are subject to review and acceptance by the Owner.
2. The rotating drum filter shall be provided by a manufacturer with the ability to document a minimum of five installations with similar flow rates and loading characteristics.
3. The rotating drum filter manufacturer shall review the installation drawings for the drum filter. If special mounting, sealing, or support items are needed for proper installation the drum filter manufacturer shall provide these items as part of the equipment supplied.

B. Rotating Drum Filter Design and Operation

1. The rotating drum filter shall consist of the drum rotation driveline, filter elements, drum tank (if required) and cover structure, spray bar, sludge trough, support bearings, liquid level controls, high pressure rinse system and cover.
2. The rotating drum filter shall operate by passing influent solids laden water into the interior of the drum cavity. Influent water shall flow by gravity through the filter elements causing solids to impinge on the interior side of the filter elements. The water level in the drum cavity will rise due to filter occlusion until the liquid level control mechanism (or timer when in timer mode) activates a high pressure rinse bar (by way of solenoid valve and backwash pump) to backwash the solids off the filter elements into a sludge trough. Simultaneously, a driveline shall turn the drum exposing all filter elements to the backwash spray. When the water level inside the drum drops back to normal, the liquid level control mechanism shall be disengaged and activate an off-delay timer to ensure complete cleaning of elements. The cycle shall repeat itself on demand as the filter becomes loaded. In addition, the filter shall be provided with a high level alarm float switch to alarm a condition when the filter is not cleaning adequately. The drum filter shall be provided in a packaged system complete with all controls, sensors, motor starters, pumps, throttling valves, solenoid valves and wiring shall be included for installation as shown in the Drawings. The units shall be pre-wired, plumbed, and assembled in the factory to greatest extent possible.
3. The rotating drum filter shall be capable of continuous filtration of water under the following conditions:
 - a. Capacity: 1600 GPM
 - b. Influent Water Quality: 70 mg/L during tank cleaning
 - c. Media Opening: 60 Micron
4. Any opening in or around the drum filter frame through which personnel could step shall be covered with stainless steel, aluminum or FRP material suitable for foot traffic.

C. Drum Filter Components

1. Driveline. The drum filters shall have helical worm gearbox coupled to the drum filter drive shaft with riveted roller chain and sprockets. The drum filters shall be provided with #80 riveted roller chain. The chain shall run in a continuous oil bath for extend life and corrosion resistance unless approved otherwise by Owner.
2. Filter Element. The filter cloth shall be of the micron rating indicated above and shall be bonded to polyethylene grids measuring. Individual filter elements shall be easily removed without removal or disengagement of addition filter elements. Filter elements shall be sealed to the drum structure utilizing EDPM type gasket material to provide watertight closer.
3. Drum Seal. The drum seal shall provide continuous and positive protection against particles from bypassing the filter elements.

4. Drum Support. The drum shall be supported on the three-point bearing system utilizing POM plastic grease fitted roller bearings. The drum shaft shall be constructed of AISI 316SS and bolted to the drum structure.
 5. Spray Bar. The rotating drum filter shall have one common spray bar providing multiple nozzles per filter element width to provide overlapping coverage. The nozzles shall be quick release type to allow for easy cleaning, construction with nylon quick release cap and stainless-steel spray tip.
 6. High Pressure Rinse and Level Control System. The backwash system including all required pumps, piping, level sensors, throttling valves, solenoid valves, nozzle protection strainers and controls shall be provided by the filter manufacturer as a package system. Backwash spray system pumps shall draw water through a stainless-steel foot valve from the filtered water side of the drum filter, unless shown otherwise on the Drawings. The system shall be capable of supplying water to the drum filter backwash system nozzles at a pressure of 100 psi or greater at the flow required to clean the filters.
 7. Frame, Cover and Weir Pan. The drum filter shall be provided with a 304 stainless steel self-leveling weir pan integral with the drum structure. It shall also have an easily removable cover, constructed of 304 stainless steel or aluminum or FRP and designed specifically for the drum filter provided.
 8. Alarms. The rotating drum filter shall be provided with an alarm float switch. The high-level alarm setting shall be adjustable and set initially to activate the alarm if the water rises 2 inches above the level setting that activates the backwash system.
 9. Electric Starting Current. To avoid overloading the generator, motors must be provided with a soft-starter or stepped onto generator power with an adjustable time delay.
- D. Drum Filter Spare Parts
1. Spare parts shall be delivered in labeled containers suitable for storage at the project site.
 2. Furnish one rubber lip seal, drive motor, gear box, bearings for center shaft and at least 10% of one complete set of filter panels in each mesh size required with at least 10% of one complete set of straps, nuts and bolts. Also, for each drum filter, furnish 25% of one complete set of nozzles with nuts and gaskets and one complete set of boogie support wheels with bearings and shafts.
- E. Backwash Pump
1. The pump shall be of the multi-stage design with the motor mounted directly to the pump.
 2. The pump shall have a mechanical seal of tungsten or silicon carbide.
 3. The pump shaft and housing shall be constructed of stainless steel. The motor stool shall be constructed of cast iron. The pump shaft coupling shall be constructed of cast iron.
 4. The pump motor shall be sized to ensure the pump is non-overloading when operating on the specified pump curve. Motor design shall be totally enclosed fan cooled with a NEMA C face design operating at a nominal 3,450 RPM with a minimum service factor of 1.15. Lower motor bearings shall be adequately sized to insure long motor life.
 5. Manufacturers and Models:
 - a. Goulds: GB Series.
 - b. Webtrol: EZ with options.
- F. Wye Strainers/Filters for nozzle protection
1. Filters/Strainers shall have 80 – 100 mesh (or 130 micron) stainless steel filter with free area at least three times the area of the inlet pipe. Amiad is one maker of such strainers.
 2. Filter/Strainers shall have a ½ IN or ¾ IN full port “blow-off”/drain connection and stainless or polyethylene ball valve.
 3. Strainers shall have reinforced polyester body and cover that is secured by not more than four fasteners, removable without the use of tools. Units shall be rated to at least 150 psi.
 4. Provide hose and adapters and a full-size bronze globe valve all suitable for 150 psi operating pressure.

G. Controls

1. Electrical components shall be enclosed in a hinged door, NEMA 4X enclosure, one control panel for each drum assembly. Provide adequate cooling for equipment enclosed for 40 C ambient air.
2. Provide a control power transformer of sufficient capacity for the control components. Provide two-primary fuses and one secondary fuse. Ground transformer per NEC.
3. Provide a “hand-off-auto” selector switch for the drum filter drive and a “hand-off-auto” selector switch for the backwash pump.
4. Provide a three-position “mode of operation” selector switch. The switch is used to select one of three modes of automatic operation; - Float Switch; - 24-hour timer; or - Float Switch and 24-hour timer.
5. Provide controls to set the time clock interval and backwash duration. “Interval” is the time between backwash operations, and “duration” is the minimum amount of time the backwash operates.
6. A float switch shall be factory mounted to sense drum filter effluent level and initiate a backwash cycle when that level drops to 8 IN below normal influent level. Another float switch shall be factory mounted to the drum filter to sense effluent level and activate a low-level alarm when effluent level reaches 12 IN below the emergency overflow weir of the drum filter. A 3rd float switch shall be factory mounted to the drum filter to sense influent water level and shall activate a high-water level alarm when the emergency overflow level is reached. All float switches shall be adjustable.
7. Each control panel shall include a solid-state “soft-start” and “soft-stop” motor starter with thermal overload relay for control of the backwash pump.
8. Each control panel shall include a “variable frequency drive” or “soft-start” and “soft-stop” motor controller for the drum motor.
9. Include run time meter for each motor. Run time meters shall be 120-volt and not re-settable from the control panel face. Run time meters requiring batteries will not be allowed.
10. The control panel shall include all electrical components required to operate the drum filter including a control power transformer, timing relays and control relays.
11. The control panel shall include terminal blocks for connection of all field wiring. One terminal shall be provided for each control wire and each power lead.
12. Control panels shall include indicating lights for each alarm including low level alarm, high level alarm, drive motor VFD fault, and backwash pump overload. The alarm lights shall remain lit until the alarm is reset from the control panel. A single N.O. alarm contact (non-flashing) shall be provided for connection to the hatchery alarm system.
13. The controls shall be designed to automatically restart after a power failure.

H. Drum Filter Electrical

1. The drum filter assembly shall be provided as a complete package with the drive motor, 316 SS magnetic float switches and NEMA 4X stainless steel junction box with wiring terminals for all field wires. One terminal shall be provided for each control wire and for each motor lead.
2. Appropriate lengths of ½ IN, UL listed, flexible non-metallic conduit with watertight connectors shall be provided for connection to the gear motor, backwash pump and float switches.

- I. One float switch shall be provided for activation of the backwash cycle and one float switch for high level alarm and one for low level alarm.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Packaged Rotating Drum Filter
 - 1. Contractor shall install the rotating drum filter in strict accordance with the manufacturer's directions, and the drawings. The equipment shall be fully covered and protected at all times during installation and construction.
 - 2. The drum filter manufacturer shall provide (2) 8-hour site visits; (1) at startup and (1) for operations training refresher by factory-trained representative. Three (3) copies of the operations manual shall be provided at the startup and training.

3.2 TESTING

- A. After filter equipment has been installed, contractor shall perform an operational test. Contractor shall monitor head loss of the system under rated flow rate. Contractor shall provide all test equipment and labor for test. Any damage resulting from or caused by the test shall be repaired at contractor's expense.
- B. Perform all tests under supervision of Owner. A factory representative shall be available by phone for consultation during the testing period

END OF SECTION