



PROJECT MANUAL

FOR THE CONSTRUCTION OF A DISINFECTION CONTACT BASIN AT THE GREEN CANYON WATER TREATMENT PLANT

Consultant Project Number 70081-002

ENGINEER

**Hazen and Sawyer
10619 South Jordan Gateway, Suite 130
South Jordan, UT 84095**

OCTOBER 2024

**TECHNICAL SPECIFICATIONS – SUBMITTAL 100%
DESIGN ISSUED FOR CONSTRUCTION
VOLUME 1 OF 2**

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SECTION 00.01.01

TITLE PAGE AND PE CERTIFICATIONS

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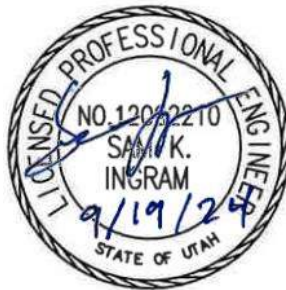
OCTOBER 2024

Professional Engineer Certifications



PARRY OSBORN, PE

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Divisions: Civil/Mechanical



SAMUEL INGRAM, PE

License No. 12092210
Divisions: Structural



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License No. 11959051
Divisions: Electrical/Controls

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SECTION 00 11 00

NORTH LOGAN CITY
GREEN CANYON WATER TREATMENT PLANT
DISINFECTION CONTACT BASIN

ADVERTISEMENT FOR BIDS

PROJECT: **GREEN CANYON WATER TREATMENT PLANT *DISINFECTION CONTACT BASIN***

EMAILED BIDS WILL BE RECEIVED BY: **PARRY OSBORN**
(*POSBORN@HAZENANDSAWYER.COM*)

UNTIL: **2:00 PM NOVEMBER 5, 2024**

Emailed Bids for the construction of the indicated project will be received via email as indicated above. Bids will be publicly opened and read aloud in the North Logan City Offices that time by the Engineer. All Bids submitted shall include one original (digital PDF) set of the Bid Documents.

The Work is located at the Green Canyon Water Treatment Plant located at the mouth of Green Canyon in North Logan City. The plant's approximate address is 1876 Green Canyon Drive, North Logan, Utah 84341. The Work consists of the following:

- Excavation for a new disinfection contact basin
- Construction of a at grade concrete disinfection contact basin
- Construction of a new meter vault
- Addition of a new electrical sub panel, rewiring, and new electrical to support the new construction
- Replacement of the existing chlorine dosing equipment
- Installation of miscellaneous valves, instrumentation, piping, and electrical

The Work will not be funded through a federal or state loan; there are no federal cross-cutter requirements. OWNER is using a loan through the Board of Water Resources that has minor reporting requirements. The selected CONTRACTOR Will be required to assist OWNER in ensuring compliance; effort is expected to be minimal.

Bids will be received for a **SINGLE** prime Contract. Bids shall be on a **LUMP SUM, PRICE BASIS**, as indicated on the Bid Form. The Contract Times for the Work are set forth in the Agreement.

The Issuing Office for the Bidding Documents is:

Hazen and Sawyer
Attn: Parry Osborn, PE
10619 South Jordan Gateway, Suite 130
South Jordan, Utah 84095
posborn@hazenandsawyer.com

Bidding Documents may be viewed and downloaded online by registering with the Issuing Office by emailing Parry Osborn, PE at the email address listed above.

Following emailed request, complete sets of Bidding Documents may be downloaded from the Issuing Office's website as "zipped" portable document format (PDF) files. No printed copies of bidding documents will be provided by owner. All printed copies are the responsibility of the bidding contractor.

Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents, including any addenda, obtained from a source other than the Issuing Office.

Each Bidder must be a Bidding Document Holder. Bids submitted by Bidders not on the list of Bidding Documents (Plan) Holders with the Issuing Office will not be opened.

A Mandatory pre-Bid Conference will be held at the North Logan City Offices on October 16th at 10:00 am.

Bid security shall be furnished in accordance with the Instructions to Bidders.

Bidders shall submit proof of qualifications to perform the Work as described in the Instructions to Bidders.

Owner: _____

By: _____

Title: _____

Date: _____

To Be Advertised: _____

END OF ADVERTISEMENT FOR BIDS

SECTION 00 20 00
INSTRUCTIONS TO BIDDERS

1. Defined Terms
2. Bids Received
3. Location and Description of Project
4. Copies of Bidding Documents
5. Qualifications of Bidders
6. Examination of Bidding Documents, Other Related Data and Site
7. Pre-Bid Conference
8. Site and Other Areas
9. Interpretations and Addenda
10. Bid Security
11. Contract Times
12. Liquidated and Special Damages
13. Substitute and "Or Equal" Items
14. Subcontractors, Suppliers and Others
15. Preparation of Bid
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17. Submittal of Bid
18. Modification or Withdrawal of Bid
19. Opening of Bids
20. Disqualification of Bidders
21. Bids to Remain Subject to Acceptance
22. Evaluation of Bids and Award of Contract

23. Contract Securities
24. Contractor's Insurance
25. Signing of Agreement
26. Notice to Proceed
27. Sales and Use Taxes
28. Additional Requirements
 - a. Local Procurement Protest Procedure

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 which are applicable to both the singular and plural thereof.
 - A. Issuing Office: The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
 - B. Bidding Documents Holder: A party recorded by Engineer as having obtained the Bidding Documents as required by the Advertisement for Bids.

ARTICLE 2 – BIDS RECEIVED

- 2.01 Refer to the Advertisement for Bids for information on receipt of Bids.

ARTICLE 3 – LOCATION AND DESCRIPTION OF PROJECT

- 3.01 Refer to Section 01 11 00 – Summary of Work, in the General Requirements for the location and description of the Project.

ARTICLE 4 – COPIES OF BIDDING DOCUMENTS

- 4.01 Refer to the Advertisement for Bids for information on location where Bidders may examine and obtain the Bidding Documents.

- 4.02 Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
- 4.03 Owner and Engineer in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not grant permission for any other use.

ARTICLE 5 – QUALIFICATIONS OF BIDDERS

- 5.01 Bidders shall be experienced in the kind of Work to be performed, shall have the necessary equipment therefore, and shall possess sufficient capital to properly execute 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 that Bidder has the necessary ability, plant, and equipment 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.
- 5.02 To demonstrate qualifications to perform the Work, Bidder shall complete and submit with its Bid the Bidder Qualifications Statement. Bidders may be asked to and shall furnish additional data to demonstrate Bidder's qualifications.
- 5.03 Bidders shall be qualified to do business in the state where the Project is located or covenant to obtain such qualification prior to signing the Agreement.
- 5.04 Each Bidder must be a Bidding Document Holder. Bids submitted by Bidders not on the list of Bidding Documents (Plan) Holders will not be opened.

ARTICLE 6 – EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA AND SITE

- 6.01 Subsurface and Physical Conditions
 - A. Supplementary Conditions identify:
 - 1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site that have been utilized by Engineer in preparation of the Bidding Documents.
 - 2. Drawings of physical conditions relating to existing surface or subsurface structures (except underground Facilities), which are at or contiguous to the Site, that have been utilized by Engineer in preparation of Bidding Documents.

6.02 Underground Facilities – Physical Conditions

- A. Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

6.03 Hazardous Environmental Condition

- A. Owner has no actual knowledge of a Hazardous Environmental Condition at the Site.

6.04 Provisions concerning responsibilities for the adequacy of data, furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unforeseen subsurface or physical conditions appear in Paragraphs 4.02, 4.03, 4.04 and 4.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work appear in Paragraph 4.06 of the General Conditions.

6.05 Other Related Data (Not Used).

6.06 On request, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a Bid. Bidder shall fill all holes and clean up and restore the Site to its original conditions upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all Laws and Regulations relative to such explorations, investigations, tests, and studies.

- A. On request, Owner will conduct a Site visit during Owner's normal business hours. Contact Zac Root to schedule. Requests shall be made at least 72-hours in advance of proposed Site visit and at least five (5) days prior to opening of Bids.

- B. Owner will conduct a Site Walk through during the Pre-Bid Conference.

6.07 Reference is made to Section 01 11 00 – Summary of Work for identification of the general nature of other work to be performed at the Site by Owner or others (such as utilities and other prime contractors) that relates to the Work for which a Bid is to be submitted. On request, Owner will provide to Bidder, for examination, access to or copies of the contract documents for such other work.

6.08 It is the responsibility of Bidder, before submitting a Bid to:

- A. Examine and carefully study the Bidding Documents, the other related data identified in the Bidding Documents and Addenda (if any);
 - B. Visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;
 - C. Become familiar with and satisfy Bidder as to the Laws and Regulations that may affect cost, progress and performance of the Work;
 - D. Consider the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in Bidding Documents, including “technical data,” with respect to the effect of such information, observation, and documents on:
 - 1. The cost, progress and performance of the Work;
 - 2. The means, methods, techniques, sequences and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences and procedures of construction expressly required by the Bidding Documents; and
 - 3. Bidder’s safety precautions and programs;
 - E. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for the performance of the Work at the price(s) bid and within the times required and in accordance with the other terms and conditions of the Bidding Documents;
 - F. Become aware of the general nature of work (if any) to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;
 - G. Promptly give Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and
 - H. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.
- 6.09 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 6, that without exception the Bid is premised upon performing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, or procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents

and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing the Work.

ARTICLE 7 – PRE-BID CONFERENCE

- 7.01 **A MANDATORY pre-Bid Conference** will be held at 10:00 am local time on October 16th, 2024 at the City office. Representatives of Owner and Engineer will be present to discuss the Project. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions raised at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 8 – SITE AND OTHER AREAS

- 8.01 The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner unless otherwise provided in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment, to be incorporated into the Work are to be obtained and paid for by Contractor.

ARTICLE 9 – INTERPRETATIONS AND ADDENDA

- 9.01 All questions about the meaning or intent of the Bidding Documents shall be submitted to Engineer in writing. To receive consideration, questions must be received by Engineer at least seven (7) days prior to the date for the opening of Bids. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by Engineer as having received the Bidding Documents for receipt not later than three (3) business days prior to the date for the opening of Bids. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.
- 9.02 Addenda may also be issued to clarify, correct or change the Bidding Documents as deemed advisable by Owner or Engineer. Such Addenda, if any, will be issued in the manner and within the time period stated in Paragraph 9.01 of these Instructions to Bidders.

ARTICLE 10 – BID SECURITY

- 10.01 Bids shall be accompanied by either a Bid Bond for the full amount of the Bid issued by a bonding company authorized to do business in the State of Utah; or by a certified check, cashier's check, or letter of credit **equal to 5% of the bid**, satisfactory to the Owner. The required Bid Bond(s), certified checks, cashier's checks, or letters of credit shall be made payable to **North Logan City**. The above items shall be in accordance with **Utah Code Title 63G Chapter 6A-1102**.
- 10.02 Bid bond shall be on the form (Bid Guaranty and Contract Bond) bound in the Bidding Documents. Bid bond shall be issued by a surety complying with the requirements of Paragraphs 5.01 and 5.02 of the General Conditions.
- 10.03 Bid security of the Successful Bidder will be retained until such Bidder has executed the Agreement, furnished the required contract security, and complied with the other conditions of the Notice of Award, whereupon the bid security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within **15 days** of the Notice of Award, Owner may annul the Notice of Award and may retain from the bid security an amount equal to the amount of damages set forth in **Utah Code Title 63G**.
- 10.04 Bid security of the three lowest Bidders may be retained by Owner until the earlier of the seventh day after the execution of the Agreement by the Successful Bidder or the one hundred and twenty-first day (121) or sixtieth (60) day after the Bid opening. The bid security of other Bidders will be returned within seven days of the Bid opening.
- 10.05 Successful Bidder, who submitted Bid Security by certified check, cashier's check or letter of credit, shall be required to file a performance and payment bond in the full amount of the contract pursuant to Utah Code Title 63G

ARTICLE 11 – CONTRACT TIMES

- 11.01 The number of days within which or the dates by which the Work is to be substantially completed and also completed and ready for final payment (the Contract Times) are set forth in the Agreement.

ARTICLE 12 – LIQUIDATED AND SPECIAL DAMAGES

- 12.01 Provisions for liquidated and special damages, if any, are set forth in the Agreement.

ARTICLE 13 – SUBSTITUTE AND “OR EQUAL” ITEMS

- 13.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or “or-equal” items. Whenever it is specified or described in the Bidding Documents that a substitute or “or-equal” item of material or equipment may be furnished or used by Contractor if accepted by Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement. The procedure for submittal of any such application by Contractor and consideration by Engineer is set forth in the General Conditions which may be supplemented in the General Requirements (Division 1).
- 13.02 Refer to Section 01 25 00 – Substitution Procedures of the General Requirements for the period of time after the Effective Date of the Agreement during which the Engineer will accept applications for substitute items of material or equipment.

ARTICLE 14 – SUBCONTRACTORS, SUPPLIERS AND OTHERS

- 14.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within five (5) days after Bid opening submit to Owner a list of all such Subcontractors, Suppliers, other individuals, and entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualifications for each such Subcontractor, Supplier, individual, and entity if requested by Owner. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request the apparent Successful Bidder to submit an acceptable substitute without an increase in the Bid price.
- 14.02 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers and other individuals or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.06 of the General Conditions.
- 14.03 Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.

ARTICLE 15 – PREPARATION OF BIDS

- 15.01 A Bid shall be made on the Bid Form bound in Project Manual. The Bid Form shall not be separated from the Bid Submittal Document nor shall it be altered in any way. The entire Bid Submittal Document must be submitted. Only the completed Bid Submittal Document is required to be submitted.
- 15.02 All blanks in the Bid Form shall be completed in ink or by a typewriter and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each Bid Item listed therein. In the case of optional alternatives, the words “No Bid”, “No Change”, or “Not Applicable” may be entered. Ditto marks shall not be used.
- 15.03 A Bid shall be executed as stated below.
- A. A Bid by an individual shall indicate the Bidder’s name and official address.
 - B. A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title shall appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be indicated.
 - C. A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be indicated.
 - D. A Bid by a corporation shall be executed in the corporate name by an officer of the corporation and shall be accompanied by a certified copy of a resolution of the board of directors authorizing the person signing the Bid to do so on behalf of the corporation. The corporate seal shall be affixed and attested by the secretary or an assistant secretary of the corporation. The state of incorporation and the official corporate address shall be indicated.
 - E. A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be indicated below the signature.
 - F. All names shall be typed printed in ink below the signature.
 - G. If applicable, the Bid shall contain evidence of Bidder’s authority and qualification to do business in the state where the Project is located or Bidder shall agree in writing to obtain such authority and qualification prior to award of Contract and attach such statement to the Bid.
 - H. Contractor’s license or registration number, if any, shall be entered in the space provided on the Bid Form.

- 15.04 Bid shall contain an acknowledgment of the receipt of all Addenda, the numbers of which shall be filled in at the space provided on the Bid Form.
- 15.05 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be indicated.
- 15.06 The following listed documents are the Bid Submittal Document and shall be submitted with the Bid. Each document shall be executed in the manner described in Paragraph 15.03 unless another manner is indicated.
- A. Bid Form (Section 00 40 00 – Bid Form).

ARTICLE 16 – BASIS OF BIDS; COMPARISON OF BIDS

- 16.01 Single Lump Sum
- A. Bidder shall submit Bid on the basis of single lump sum as set forth in the Bid Form. Bidder shall include write-in bid amounts and allowances as set forth in the Bid Form and as described in Section 01 20 00 – Measurement and Payment.
- 16.02 Discrepancies between words and numerals will be resolved in favor of words. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.
- 16.03 Bidder shall include, elsewhere in Bid, costs set forth in Paragraph 11.02.B of the General Conditions to complete the Work associated with the material, equipment, or other designated items to be furnished under cash allowance(s).

ARTICLE 17 – SUBMITTAL OF BID

- 17.01 A Bid shall be received no later than the date and time prescribed and at the place indicated in the Advertisement for Bids.
- 17.02 Bid shall be enclosed in an opaque sealed envelope plainly marked on the outside with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted) the name and address of the Bidder and its license or registration number, if applicable. Bid shall be accompanied by Bid security and other required documents.
- 17.03 If the Bid is sent by mail or other delivery method, the sealed envelope containing the Bid shall be enclosed in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED". A mailed Bid shall be addressed to the same address as indicated in the Advertisement for Bids.

ARTICLE 18 – MODIFICATION OR WITHDRAWAL OF BID

18.01 Withdrawal Prior to Bid Opening:

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

18.02 Modification Prior to Bid Opening:

- A. If a Bidder wishes to modify its Bid, Bidder must withdraw its initial Bid in the manner specified in Paragraph 18.01.A of these Instructions to Bidders and submit a new Bid.

ARTICLE 19 – OPENING OF BIDS

19.01 Bids will be opened at the time and place where Bids are to be submitted and, unless obviously non-responsive, read aloud publicly. An abstract of the Bids will be made available to Bidders after the opening.

19.02 Bids received by mail or otherwise after the date and time specified for the opening of Bids will not be accepted and will be returned to the Bidder unopened.

ARTICLE 20 – DISQUALIFICATION OF BIDDERS

20.01 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

ARTICLE 21 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 22 – EVALUATION OF BIDS AND AWARD OF CONTRACT

22.01 Owner reserves the right to reject any or all Bids, including without limitation the right to reject any or all nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be not responsible. Owner also reserves the right to waive any informality not involving price, time or changes in the Work.

- 22.02 Owner reserves the right to reject any Bid not accompanied by specified documentation and Bid security.
- 22.03 Owner reserves the right to reject any Bid that, in its sole discretion, is considered to be unbalanced or unreasonable as to the amount bid for any lump sum or unit price item.
- 22.04 In evaluating Bidders, Owner will consider the qualifications of Bidders, whether or not their Bids comply with the prescribed requirements, the alternatives, if any, the lump sum and unit prices, and other data as may be requested in the Bid Form or prior to the Notice of Award.
- 22.05 Owner may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the Supplementary Conditions.
- 22.06 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of the Bidders to perform the Work in accordance with the Contract Documents. Owner reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to Owner's satisfaction.
- 22.07 Owner reserves the right to reject any and all Bids, to waive any informalities or irregularities, and further, reserves the right to accept any Bids or parts of Bids. Owner reserves the right to accept any Bid deemed to be in its best interests even though the Bid chosen may result in the award of the Contract to a Bidder whose Bid is not, on a mathematical basis alone, the low Bid.
- 22.08 If a Contract is to be awarded, Owner will award the Contract to the lowest responsive, best, and responsible Bidder who has neither been disqualified nor rejected pursuant to Article 20 of the Instructions to Bidders or this Article 22.

ARTICLE 23 – CONTRACT SECURITIES

- 23.01 Performance and Payment Bond shall be in the full amount of the Bid. The amounts of and other requirements for Performance and Payment Bonds are stated in Paragraph 5.01 of the General Conditions. The requirements for delivery of Bonds are stated in Paragraph 2.01 of the General Conditions. Additional requirements may be stated in the Supplementary Conditions.

ARTICLE 24 – CONTRACTOR'S INSURANCE

- 24.01 Successful Bidder shall within fifteen (15) days from the date of the Notice of Award deliver to Owner, for review and approval, the required policies of insurance. Upon approval, the policies will be returned to the Bidder and Bidder shall submit certificates of

insurance and other evidence of insurance to the Owner as stated in the General Conditions.

ARTICLE 25 – SIGNING OF AGREEMENT

25.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement along with the other Contract Documents which are identified in the Agreement as attached thereto. Within fifteen (15) days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within ten days thereafter, Owner will deliver one fully signed counterpart to Successful Bidder.

ARTICLE 26 – NOTICE TO PROCEED

26.01 Issuance of the Notice to Proceed shall be as stated in Article 2 of the General Conditions.

ARTICLE 27 – SALES AND USE TAXES

27.01 Refer to the Paragraph SC-6.10 of the Supplementary Conditions for information on Owner's inclusion and/or exemption from sales and use taxes on materials and equipment to be incorporated into the Work.

ARTICLE 28 – ADDITIONAL REQUIREMENTS

28.01 The Bidder to whom the Contract is awarded shall disclose in writing the knowledge of any business relationship or interest that any Owner employee, an employee's immediate family, or any other contractor or subcontractor of said Successful Bidder may have with the Successful Bidder.

28.02 Local Procurement Protest Procedure:

- A. A protest based upon an alleged violation of the procurement requirement may be filed against the Owner's procurement action by a party with an adversely affected direct financial interest. The protest shall be filed with the Financial Officer. The Owner shall determine the protest. The Owner may request additional information or a hearing in order to resolve the protest.
- B. A protest shall be filed as early as possible during the procurement process but must be received by the Owner no later than five (5) days after the basis of the protest is known or should have been known, whichever is earlier. If the protest is mailed, the protester bears the risk of non-delivery within the required time period.

- C. A protest must clearly present the procurement requirement being protested, the facts which support the protest, and any other information necessary to support the protest.

END OF INSTRUCTIONS TO BIDDERS

SECTION 00 40 00

BID FORM

TABLE OF ARTICLES

1. Bid Recipient
2. Bidder's Acknowledgements
3. Bidder's Representations
4. Bidder's Certifications
5. Basis of Bid
6. Certified List of Subcontractors
7. Certification of Equipment/Materials Manufacturers
8. Time of Completion
9. List of Required Attachments to this Bid
10. Defined Terms
11. Bid Submittal

ARTICLE 1 – BID RECIPIENT

- 1.01 This Bid is submitted to:

NORTH LOGAN CITY
Care of Hazen and Sawyer
Attn: Parry Osborn, PE
10619 South Jordan Gateway, Suite 130
South Jordan, UT 84095
posborn@hazenandsawyer.com

- 1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the

price(s) and within the times indicated in this Bid and in accordance with the Bidding Documents.

ARTICLE 2 – BIDDER’S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 120 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner. Bidder will sign the Agreement and will furnish the required contract security, and other required documents within the time periods set forth in the Bidding Documents.

ARTICLE 3 – BIDDER’S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, other related data identified in the Bidding Documents, if any, and the following Addenda, receipt of all of which is hereby acknowledged.

Addendum No.	Date Received	Addendum No.	Date Received

- B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
- C. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.
- D. Bidder has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities), if any, that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”.
- E. Bidder has considered the information known to Bidder, information commonly known to contractors doing business in the locality of the Site, information and

observations obtained from visits to the Site, the Bidding Documents, and the Site-related reports and drawings identified in the Bidding Documents with respect to the effect of such information, observations, and documents on:

1. The cost, progress and performance of the Work.
 2. The means, methods, techniques, sequences and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder.
 3. Bidder's safety precautions and programs.
- F. Based on the information and observations referred to in Paragraph 3.01.E, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times required and in accordance with the other terms and conditions of the Bidding Documents.
- G. Bidder is aware of the general nature of work (if any) to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
- H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.
- I. Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.

ARTICLE 4 – BIDDER'S CERTIFICATIONS

4.01 Bidder certifies that:

- A. This Bid is genuine and is not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation.
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not engaged in corrupt, fraudulent, collusive or coercive practices in competing for the Contract. For the purposes of the Paragraph 4.01.D.

1. "Corrupt practice" means the offering, giving, or soliciting of anything of value likely to influence the action of a public official in the bidding process
2. "Fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition.
3. "Collusive practice" means to 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.
4. "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 – BASIS OF BID

- 5.01 Bidder will complete the Work in accordance with the Contract Documents for the amount as listed below. Total bid amount(s) shall be shown in words and numbers. In case of discrepancy, the bid amount shown in words will govern.

Item	Description	Unit	Qty.	Item Bid Price
1	MOBILIZATION	LS	1	\$
2	GENERAL – TEMPORARY FENCING	LF	750	\$
3	GENERAL – UTILITIES LOCATION AND MARKING	LS	1	\$
4	GENERAL – POTHOLING	Each	10	\$
5	GENERAL – TEMPORARY RELOCATION OF 6-INCH WELL WATER LINE (INCLUDING VALVES AND CAPS)	LS	1	\$
6	CIVIL – EXCAVATION	CY	6400	\$
7	CIVIL – HAULING AND DISPOSING SPOILS	CY	4000	\$
8	CIVIL – SHORING	LS	1	\$
9	CIVIL – YARD PIPING AND VAULT	LS	1	\$
10	CIVIL – FINAL GRADING	CY	3000	\$
11	STRUCTURAL – DISINFECTION CONTACT BASIN	LS	1	\$
12	PROCESS MECHANICAL – SAMPLE PUMP, PIPING, CHLORINE ANALYZER, MISC VALVES, AND FITTINGS	LS	1	\$
13	PROCESS MECHANICAL – CHLORINATOR	LS	1	\$
14	ELECTRICAL – PANEL REPLACEMENT, NEW CONDUIT AND NEW PANEL	LS	1	\$
15	ALL OTHER ELEMENTS OF THE WORK NOT INCLUDED IN OTHER ITEMS AS IT PERTAINS TO THE CONTRACT DOCUMENTS	LS	1	\$
16	3" PAVEMENT RESTORATION/REPAIR	SQF T	400	\$
17	STARTUP AND DEMOBILIZATION	LS	1	\$
TOTAL SINGLE PRIME BASE BID AMOUNT (SUM OF ITEMS 1 THROUGH 17)				\$

ARTICLE 6 – CERTIFIED LIST OF SUBCONTRACTORS

6.01 The Bidder,

_____ ,

as part of the procedure for the submission of Bids on this project entitled Green Canyon WTP Disinfection Contact Basin, submits the following list of Subcontractors to be used in the performance of work to be done on said Project. The list shall include all Subcontractors who will be subcontracted to provide at least \$25,000.00 of the work, list on additional paper as required. The list of Subcontractors and all responsibilities of all disciplines shall be based on requirements of the Contract Documents. Changes to this list after the Bid opening shall only be as approved by the Owner upon request by the Contractor or as required by the Owner based on upon review of Subcontractor’s qualifications.

AREA OF SPECIALIZATION	SUBCONTRACTORS
Electrical	_____
Excavation	_____
Concrete	_____
Reinforcing Steel Supplier	_____
Paving	_____
_____	_____
_____	_____

- A. It is understood and agreed that, if awarded a Contract, the Contractor will not make any additions, deletions or substitutions to this certified list without the consent of the Owner.

**CERTIFICATION AFFIDAVIT
FOR CERTIFIED LIST OF SUBCONTRACTORS**

THE ABOVE INFORMATION IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF. I FURTHER UNDERSTAND AND AGREE THAT, IF AWARDED A CONTRACT, THIS CERTIFICATION SHALL BE ATTACHED THERETO AND BECOME A PART THEREOF.

NAME OF SIGNER:

_____ (Please Print or Type)

TITLE OF SIGNER:

_____ (Please Print or Type)

SIGNATURE: _____ DATE: _____

ARTICLE 7 – CERTIFICATION OF EQUIPMENT/MATERIAL MANUFACTURERS
NOT USED

ARTICLE 8 – TIME OF COMPLETION

- 8.01 Bidder agrees that the Work will be substantially complete and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.
- 8.02 Bidder accepts the provisions of the Agreement as to liquidated and special damages in the event of failure to complete the Work within the Contract Times.

ARTICLE 9 – ATTACHMENTS TO THIS BID

- 9.01 The following documents are attached to and made a condition of this Bid:
- A. Bidder Qualifications Statement
 - B. Bid Form
 - C. Bid Bond

ARTICLE 10 – DEFINED TERMS

- 10.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders and the General Conditions and Supplementary Conditions.

ARTICLE 11 – BID SUBMITTAL

11.01 This Bid submitted on _____, 20__ by:

If Bidder is (pick one):

AN INDIVIDUAL

Name: _____
(Typed or Printed)

By: _____
(Individual's Signature)

Doing business as: _____
License or Registration
Number: _____

Business Address: _____

Phone No.: _____ Fax No.: _____

E-mail: _____

A PARTNERSHIP

Partnership Name: _____

By: _____
(Signature of General Partner - Attach evidence of authority to sign)

Name: _____
(Typed or Printed)

License or Registration
Number: _____

Business Address: _____

Phone No.: _____ Fax No.: _____

E-mail: _____

CORPORATION

Corporation Name: _____

(State of Incorporation)

By: _____
(Signature – Attach evidence of authority to sign)

Name and Title: _____
(Typed or Printed)

(CORPORATE SEAL)

Attest _____
(Secretary)

License or Registration
Number: _____

Business Address: _____

Phone No.: _____ Fax No.: _____

E-mail: _____

LIMITED LIABILITY COMPANY

By: _____
(Firm Name)

(State of Formation)

By: _____
(Signature of Member / Authorized to Sign)

(Printed or Typed Name and Title of Authorized to Sign)
(Attach evidence of authority to sign.)

License or
Registration Number: _____

Business Address: _____

Phone No.: _____ Fax No.: _____

E-mail: _____

A JOINT VENTURE

Name of Joint Venture: _____
First Joint Venturer
Name: _____

By: _____
(Signature of First Joint Venturer – Attach evidence of authority to sign)

Name (Typed or
Printed): _____

Title: _____

Second Joint Venturer
Name: _____

By: _____
(Signature of First Joint Venturer – Attach evidence of authority to sign)

Name (Typed or
Printed): _____

Title: _____

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

Business Address: _____

Phone and fax numbers and address for receipt of communications to joint venture.

Phone No.: _____ Fax No.: _____

E-mail: _____

END OF BID FORM

**SECTION 00 51 00
NOTICE OF AWARD**

To: _____ Date: _____, 20____

The City of North Logan, herein called Owner, represented by the undersigned has considered the Bid submitted by you for the Work and any adopted alternatives in response to its Invitation to Bid and Instructions to Bidders dated _____, 20__.

Determined to be in Owner's best interest, the Owner accepts your Bid in the amount of _____

and intends to execute the Agreement for this Work. You are hereby notified that your Bid has been accepted for the Work. You are required by the Instructions to Bidders to execute the formal Agreement with the undersigned Owner and to furnish the required Contractor's Performance Bond and Payment Bond, proper Insurance Certificate and other required Contract Documents within fifteen (15) days from the date of delivery of this Notice to you. **You are required to return an acknowledged copy of this Notice of Intent to Award and all copies of the signed Agreement (leave dates blank) to the Owner for execution.**

If you fail to execute said Agreement and to furnish said bonds and certificates within 15 days from the date of delivery of this Notice, said Owner will be entitled to consider all your rights arising out of the Owner's acceptance of your Bid as abandoned and as a forfeiture of your Bid Security. The Owner will be entitled to such other rights as may be granted by law and to award the Work covered by your Bid to another, or to re-advertise the Work or otherwise dispose thereof as the Owner may see fit.

Dated this ____ day of _____, 20_____.

Owner

By: _____

ACCEPTANCE OF NOTICE

Receipt of the above Notice of Award is hereby acknowledged this

_____ day of _____, 20_____.

By: _____

Title: _____

END OF NOTICE OF AWARD

SECTION 00 52 00

AGREEMENT

THIS AGREEMENT is by and between the City of North Logan (hereinafter called Owner) and _____ (hereinafter called Contractor).

Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 – WORK

- 1.01 Contractor shall at its own cost and expense furnish all labor, services, tools, materials, equipment, and incidentals necessary to complete all Work as specified or indicated in the Contract Documents to construct the Green Canyon WTP Disinfection Contact Basin. The Work is generally described in Section 01 11 00 – Summary of Work of the General Requirements.

ARTICLE 2 – PROJECT

- 2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:
- A. Construction of a new buried concrete disinfection contact basin
 - B. Replacement of existing electrical panel to sub feed a new sub-panel.
 - C. Replacement of chlorine dosing equipment
 - D. Construction of a new concrete vault with flowmeter and valves
 - E. Connection of new piping to existing piping to and from the Disinfection Contact Basin

ARTICLE 3 – ENGINEER

- 3.01 The Project has been designed by Hazen and Sawyer, (10619 S Jordan Gateway, Suite 130, South Jordan, UT 84095) (hereinafter called Engineer), which is to act as Owner's representative, assume all duties and responsibilities and have the rights and authority assigned to Engineer in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE 4 – CONTRACT TIMES

4.01 Time 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.
- B. Project Milestones:
 - 1. Milestone 1: Completion of Shutdown No. 1 within 91 days after the date when the Contract Times commence.
 - 2. Milestone 2: Completion of Shutdown No. 3 within 428 days after the date when the Contract Times commence.

4.02 Days to Achieve Substantial Completion and Final Payment

- A. The Work shall be substantially completed within 240 calendar days after the date when the Contract Times commence to run as provided in the General Conditions, and completed and ready for final payment in accordance with the General Conditions within 270 calendar days from the date when the Contract Times commence to run.

4.03 Liquidated Damages

- A. Owner and Contractor recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial loss, apart from the costs described in Paragraph 4.04.A, if the Work is not substantially completed within the time specified in Paragraph 4.02.A for Substantial Completion, plus any extensions thereof allowed in accordance with the General Conditions. Owner and Contractor also recognize the delays, expense and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not substantially completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner \$1,000 for each day that expires after the time specified in Paragraph 4.02.A above for Substantial Completion (adjusted for changes thereof, if any, made in the General Conditions) until the Work is substantially complete.

4.04 Special Damages:

- A. In addition to the amount provided for liquidated damages, Contractor shall pay Owner the actual costs reasonably incurred by Owner for engineering and inspection forces employed by Owner relative to the Work for each day that expires after the days specified in Paragraph 4.02.A for Substantial Completion (adjusted for changes thereof, if any, made in accordance with the General Conditions) until the Work is substantially complete.

- B. After Substantial Completion, if Contractor shall neglect, refuse or fail to complete the remaining Work within the Contract Time or proper extension thereof, if any, granted by Owner, Contractor shall pay Owner the actual costs reasonably incurred by Owner for engineering and inspection forces employed by Owner relative to the Work for each day that expires after the time specified in Paragraph 4.02.A for Work to be completed and ready for final payment (adjusted for extensions thereof, if any, made in accordance with the General Conditions) until the Work is completed and ready for final payment.
- 4.05 Owner may deduct liquidated damages and special damages as determined by the provisions of this Article 4 from progress payments due Contractor under this Agreement.

ARTICLE 5 – CONTRACT PRICE

- 5.01 Owner shall pay Contractor, in current funds, for completion of the Work in accordance with the Contract Documents the prices stated in Contractor's Bid, which Bid is attached hereto and identified as Exhibit 1 of this Agreement. As provided in the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer as provided in the General Conditions. Unit prices have been computed as provided in the General Conditions.

ARTICLE 6 – PAYMENT PROCEDURES

- 6.01 Submittal and Processing of Payments
- A. Contractor shall submit Applications for Payment in accordance with the General Conditions. Applications for Payment will be processed as provided in the General Conditions.
- 6.02 Progress Payments; Retainage
- A. Owner shall make monthly progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment as recommended by Engineer. Contractor's Applications for Payment will be due on the 10th day of each month, or as otherwise mutually agreed by Owner and Contractor, during performance of the Work as provided in Paragraph 6.02.A.1. All progress payments will be on the basis of the progress of the Work measured by the Schedule of Values provided for in the General Conditions. A progress payment will not be made whenever the value of the Work completed since the last previous progress payment is less than \$5,000.
- 6.03 Final Payment:

- A. Upon final completion and acceptance of the Work in accordance with the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in the General Conditions.

ARTICLE 7 – INTEREST

NOT USED

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

- 8.01 As part of the inducement for Owner to enter into this Agreement, Contractor makes the following representations:
 - A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.
 - B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
 - C. Contractor is familiar with and is satisfied as to the Laws and Regulations that may affect cost, progress, and performance of the Work.
 - D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); if any, that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”, and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in Section 01 11 00 – Summary of Work as containing reliable “technical data”.
 - E. Contractor has considered the information known to Contractor; 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 Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on:
 - 1. The cost, progress, and performance of the Work;
 - 2. The means, methods, techniques, sequences and procedures of construction to be employed by Contractor, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents, and;

3. Contractor's safety precautions and programs.
- F. Based on the information and observations referred to in Paragraph 8.01.E above, Contractor does not consider that 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 Documents.
 - G. 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.
 - H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents and the written resolution thereof by Engineer is acceptable to Contractor.
 - I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.
 - J. 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.

ARTICLE 9 – CONTRACT DOCUMENTS

- 9.01 The Contract Documents consist of the following:
- A. This Agreement
 - B. Contract Security
 - C. Conditions of the Contract
 - D. Specifications, as listed in the table of contents of the Project Manual
 - E. The Drawings bound to the Project Manual, comprising a set entitled "Green Canyon Water Treatment Plant Disinfection Contact Basin Design", and including the following:
 1. Drawings number 1 through 41.
 - F. Addenda consisting of number 1 through _____, inclusive.
 - G. The following, which may be delivered or issued on or after the Effective Date of the Agreement, and are not attached hereto:
 1. Notice to Proceed.

2. Work Change Directive(s)
 3. Change Order(s)
 4. Field Order(s)
- 9.02 The documents listed in Paragraph 9.01 above are attached to this Agreement (except as expressly noted otherwise above). Documents not attached are incorporated by reference. There are no Contract Documents other than those listed in this Article 9.
- 9.03 The Contract Documents may only be amended or supplemented as provided in the General Conditions.

ARTICLE 10 – MISCELLANEOUS

10.01 Terms

- A. Terms used in this Agreement will have the meanings indicated in the General Conditions and the Supplementary Conditions.

10.02 Assignment of Contract

- A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are 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 Documents.

10.03 Successors and Assigns

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

10.04 Severability

- A. Any provision or part of the Contract Documents, held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall 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.

10.05 Waiver

- A. The waiver by the Owner of any breach or violation of any term, covenant, or condition of this Agreement or of any Law or Regulation shall not be deemed to be a waiver of any other term, covenant, condition, or Law or Regulation, or of any subsequent breach or violation of the same or of any other term, covenant, condition, or Law or Regulation. The subsequent payment of any monies or fee by the Owner which may become due hereunder shall not be deemed to be a waiver of any preceding breach or violation by Contractor of any term, covenant, condition of this Agreement or of any applicable Law or Regulation.

10.06 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 10.06:
 - 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 to:
 - a. influence the bidding process or the execution of the Contract to the detriment of Owner,
 - b. establish Bid or Contract prices at artificial non-competitive levels, or
 - c. 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.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement on the day and year first written above.

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

Owner: _____ Contractor: _____

Signature: _____ Signature: _____

Name: _____ Name: _____

Title: _____ Title: _____

(CORPORATE SEAL)

(CORPORATE SEAL)

Attest _____ Attest _____

Title: _____ Title: _____

Address for giving notices

Address for giving notices

Agent for service of process: _____

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

(If Contractor is a corporation, partnership, or limited liability company, attach evidence of authority to sign.)

END OF AGREEMENT

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**SECTION 00 55 00
NOTICE TO PROCEED**

To: _____ Date: _____, 20__

You are hereby notified to commence Work in accordance with the Agreement dated _____, 20__ on or before _____, 20__. You are to complete the Work in accordance with the milestone schedule in the Agreement. The milestone work activity durations are as stated in the Agreement. Liquidated damages in the amount scheduled per calendar day for each calendar day the Work remains incomplete after its associated milestone date will be imposed unless the Contract Times are otherwise adjusted for due cause by Change Order to the Agreement.

OWNER

By: _____

Title: _____

ACCEPTANCE OF NOTICE

Receipt of the above Notice to Proceed is hereby acknowledged this

_____ day of _____, 20__.

By: _____

Title: _____

END OF NOTICE TO PROCEED

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SECTION 00 65 00
CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

This [preliminary] [final] Certificate of Substantial Completion applies to:

All Work The following specified portions of the Work:

Date of Substantial Completion

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

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work shall be as provided in the Contract, except as amended as follows: *[Note: Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 14.04 of the General Conditions.]*

Amendments to Owner's responsibilities:	<input type="checkbox"/> None
	<input type="checkbox"/> As follows:
Amendments to Contractor's responsibilities:	<input type="checkbox"/> None
	<input type="checkbox"/> As follows:

The following documents are attached to and made a part of this Certificate: *[punch list; others]*

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

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

END OF CERTIFICATE OF SUBSTANTIAL COMPLETION

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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By



Endorsed By



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GUIDELINES FOR USE OF EJCDC® C-700, STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

1.0 PURPOSE AND INTENDED USE OF THE DOCUMENT

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

2.0 OTHER DOCUMENTS

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

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

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

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

3.0 ORGANIZATION OF INFORMATION

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

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

4.0 EDITING THIS DOCUMENT

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

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

user must comply with the terms of the License Agreement, Paragraph 4.0, Document-Specific Provisions, concerning the tracking or highlighting of revisions. The following is a summary of the relevant License Agreement provisions:

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

5.0 LICENSE AGREEMENT

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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

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

- requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.
- b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.
 - c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.
 - d. A demand for money or services by a third party is not a Claim.
11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
 12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.
 13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
 14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
 15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
 16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
 17. *Cost of the Work*—See Paragraph 13.01 for definition.
 18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
 19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
 20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
 21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the

recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.
23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
 - a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.
 - b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
 - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals.
36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.
39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers’ instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion of such Work.

43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
46. *Technical Data*
- a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.
 - b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
 - c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.
47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.
48. *Unit Price Work*—Work to be paid for on the basis of unit prices.
49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

- A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. *Intent of Certain Terms or Adjectives:* The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.
- C. *Day:* The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.
- D. *Defective:* The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - 1. does not conform to the Contract Documents;
 - 2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - 3. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).
- E. *Furnish, Install, Perform, Provide*
 - 1. The word “furnish,” when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 - 2. The word “install,” when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 - 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.
 - 4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

- F. *Contract Price or Contract Times*: References to a change in “Contract Price or Contract Times” or “Contract Times or Contract Price” or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term “or both” is not expressed.
- G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

- A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).
- B. *Evidence of Contractor’s Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.
- C. *Evidence of Owner’s Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

- A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:
 - 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
 - 2. a preliminary Schedule of Submittals; and
 - 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work

into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.
 - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 - 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.
 - 4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
 - 1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

- A. *Standards Specifications, Codes, Laws and Regulations*
 - 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
 - 2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility

inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
 - a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

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

- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
 - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
 - 2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

- A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

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

4.03 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the

established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.
 - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
 - 2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.
- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
 - 1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 - 2. Abnormal weather conditions;
 - 3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
 - 4. Acts of war or terrorism.

- D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
 2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
 3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.
- E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
1. The circumstances that form the basis for the requested adjustment;
 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
 5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.
- Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.
- F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.
- G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

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

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
 2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.
- B. *Removal of Debris During Performance of the Work:* During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.
 - C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment

and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

- D. *Loading of Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

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

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

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

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

- D. *Limitations of Other Data and Documents:* Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

- A. *Notice by Contractor:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:
1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
 2. is of such a nature as to require a change in the Drawings or Specifications;
 3. differs materially from that shown or indicated in the Contract Documents; or
 4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

- B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.
- D. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- E. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in

Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
 - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
 - c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
- a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;
 - b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
 - c. Contractor failed to give the written notice required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.
- F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

- A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:
1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
 2. complying with applicable state and local utility damage prevention Laws and Regulations;

3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
 4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
 5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.
- B. *Notice by Contractor:* If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.
- C. *Engineer's Review:* Engineer will:
1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;
 2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
 3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
 4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

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

- D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.
- E. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- F. *Possible Price and Times Adjustments*
1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown

or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
 - b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
 - c. Contractor gave the notice required in Paragraph 5.05.B.
2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
 3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
 4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

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

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures

- of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.
- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.
- H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special

conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.
- B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.
- C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or

Regulations, and must be issued and signed by a surety named in “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual’s authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

- D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.
- E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.
- F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner’s termination rights under Article 16.
- G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.
- H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Alternative forms of insurance coverage, including but not limited to self-insurance and “Occupational Accident and Excess Employer’s Indemnity Policies,” are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.
- D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by

- Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.
- E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.
 - F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.
 - G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.
 - H. Contractor shall require:
 - 1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
 - 2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.
 - I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
 - J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.
 - K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

- L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.
- M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.
- N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

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

4. not seek contribution from insurance maintained by the additional insured; and
5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

- A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.
- B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.
- C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.
- D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.
- E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

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

Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
 2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.
1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.
- C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.
- D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.
- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.
- C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

- A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

- B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.
- C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
- B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

- A. *Contractor's Request; Governing Criteria:* Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that the proposed item:
 - 1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

- 2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
 - 3) has a proven record of performance and availability of responsive service; and
 - 4) is not objectionable to Owner.
- b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:
- 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.
- B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.
- D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.
- E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

- A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.
1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.
 2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
 - a. will certify that the proposed substitute item will:
 - 1) perform adequately the functions and achieve the results called for by the general design;
 - 2) be similar in substance to the item specified; and
 - 3) be suited to the same use as the item specified.
 - b. will state:
 - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
 - 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
 - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
 - c. will identify:
 - 1) all variations of the proposed substitute item from the item specified; and
 - 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
- C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

- E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
- F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.
- B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.
- E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.
- F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

- H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.
- J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.
- K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.
- L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.
- M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.
- C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

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

7.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.
- B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.
- C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
- F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
- G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

- I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

- 1. Before submitting a Shop Drawing or Sample, Contractor shall:
 - a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determine and verify:
 - 1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;
 - 2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - 3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;
 - c. confirm that the Submittal is complete with respect to all related data included in the Submittal.
- 2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.

3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.
- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.
1. *Shop Drawings*
 - a. Contractor shall submit the number of copies required in the Specifications.
 - b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.
 2. *Samples*
 - a. Contractor shall submit the number of Samples required in the Specifications.
 - b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.
 3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Engineer's Review of Shop Drawings and Samples*
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
 2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.
 3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
 4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will

document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. Resubmittal Procedures for Shop Drawings and Samples

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.
2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.
3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:
 - a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.
 - b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.
 - c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

- d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.
 2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03, 2.04, and 2.05.
- F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 Contractor's General Warranty and Guarantee

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.
- B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:
 1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
 2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.
- C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.
- D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:
 1. Observations by Engineer;
 2. Recommendation by Engineer or payment by Owner of any progress or final payment;
 3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 4. Use or occupancy of the Work or any part thereof by Owner;
 5. Any review and approval of a Shop Drawing or Sample submittal;
 6. The issuance of a notice of acceptability by Engineer;
 7. The end of the correction period established in Paragraph 15.08;
 8. Any inspection, test, or approval by others; or

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

7.18 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

- A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.
- B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.
- C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

- D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
 - 1. Checking for conformance with the requirements of this Paragraph 7.19;
 - 2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
 - 3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.
- G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.
- D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

- E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.
- F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

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

8.03 *Legal Relationships*

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

- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.
 - 1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
 - 2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.
- C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

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

9.02 *Replacement of Engineer*

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

9.03 *Furnish Data*

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

9.04 *Pay When Due*

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

- 9.05 *Lands and Easements; Reports, Tests, and Drawings*
- A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
 - B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
 - C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.
- 9.06 *Insurance*
- A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.
- 9.07 *Change Orders*
- A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.
- 9.08 *Inspections, Tests, and Approvals*
- A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.
- 9.09 *Limitations on Owner's Responsibilities*
- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- 9.10 *Undisclosed Hazardous Environmental Condition*
- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.
- 9.11 *Evidence of Financial Arrangements*
- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).
- 9.12 *Safety Programs*
- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.
 - B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

- A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.
- B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

- A. Engineer has the authority to reject Work in accordance with Article 14.
- B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.
- C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.
- D. Engineer's authority as to changes in the Work is set forth in Article 11.

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

10.05 *Determinations for Unit Price Work*

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

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

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

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

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

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

- A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
- B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.
- C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders covering:
 - 1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 - 2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
 - 3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and
 - 4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

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

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

11.04 *Field Orders*

- A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.
- B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.
- B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.
- C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);
 2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
 3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).
- C. *Contractor's Fee:* When applicable, the Contractor's fee for overhead and profit will be determined as follows:
1. A mutually acceptable fixed fee; or
 2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
 - b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;
 - c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;
 - d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
 - e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
 - f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

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

11.09 *Change Proposals*

A. *Purpose and Content:* Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal:* Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
2. *Supporting Data:* The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.
 - a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
 - b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review:* Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.
4. *Engineer's Full Review and Action on the Change Proposal:* Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change

Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.
- C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.
- D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

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

ARTICLE 12—CLAIMS

12.01 *Claims*

- A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:
 1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
 2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
 3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
 4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.
- B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge

and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

- C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation*
 - 1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
 - 2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
 - 3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.
- G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

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

13.01 *Cost of the Work*

- A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
 - 1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included:* Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.
 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.
 3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
 4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
 5. Other costs consisting of the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are

consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

- 1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

c. *Construction Equipment Rental*

- 1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.
- 2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
- 3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

- d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
- e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

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

- 1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, 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.

SECTION 00 73 00
SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement Section 00 72 00 General Conditions of the Construction Contract (EJCDC C-700, 2018 edition). The General Conditions remain in full force and effect except as amended. The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

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

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 DEFINED TERMS

[No modifications to the General Conditions via this Article of the Supplementary Conditions.]

ARTICLE 2 – PRELIMINARY MATTERS

SC 2.02 Delete Paragraph 2.02.A in its entirety and insert the following in its place:

- A. Owner shall furnish to Contractor 0 printed copies of the Contract Documents (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.

SC 2.02 Add the following new paragraph immediately following Paragraph 2.02.B:

- C. Conformed Contract Documents
 1. Owner will furnish to Contractor conformed Contract Documents incorporating and integrating Addenda and any amendments negotiated prior to the Effective Date of the Contract.
 2. Conformed Contract Documents are not Contract Documents and are provided for convenience for use during the performance of the Work and the administration of the Contract.
 3. Owner will furnish to Contractor 0 printed copies of the conformed Contract Documents and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

SC 4.01 Add the following new paragraph immediately after Paragraph 4.01.A:

- B. Commencement of Contract Times limits may be modified by mutual consent of parties of the Contract.

SC 4.05 Amend Paragraph 4.05.C by adding the following subparagraphs:

5. Weather-Related Delays

- a. If “abnormal weather conditions” as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following:
 - 1) that weather conditions were abnormal for the period of time in which the delay occurred,
 - 2) that such weather conditions could not have been reasonably anticipated, and
 - 3) that such weather conditions had an adverse effect on the Work as scheduled.
- b. The existence of abnormal weather conditions will not relieve Contractor of the obligation to demonstrate and document that delays caused by abnormal weather are specific to the planned work activities or that such activities thus delayed were on Contractor’s then-current Progress Schedule’s critical path for the Project.
- c. Contractor shall obtain weather history for the most recent five (5) years (minimum) preceding the Notice to Proceed. Weather history shall be obtained from the National Oceanic & Atmospheric Administration (NOAA) [or other source approved by the Engineer]. Historical weather shall be based on data from the weather reporting station closest to the Site.
- d. Contractor shall calculate average days for each month when rainfall and snowfall exceeds historic 90th percentile over a 24-hour period based on the historic data. The average monthly rainfall days calculated shall be rounded up to the next full day.

- e. Contractor will be awarded a time extension equal to the number of days that exceed the calculated historical monthly average days for a month.
- f. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with the following:
 - 1) For delays associated with an abnormal amount of rain, Contractor shall use the weather history to calculate an average number of days that rainfall exceeded 90th percentile over a 24-hour period starting at 7:00 p.m. on the preceding day through 7:00 p.m. on the workday in question. The Contractor will be awarded a time extension equal to the number of days, above the calculated average, that the period in question experienced rainfall (or rainfall equivalent) in excess of 90th percentile. A Contract Time extension will not be awarded for rain amounts less than 90th percentile.
 - 4) For 24-hour daily rain amounts, between 7:00 p.m. on the preceding day through 7:00 p.m. on the workday in question, in excess of 1-inch the Contractor shall be awarded one day beyond the number of days calculated as described above. The added day shall be a recovery period for the Contractor to perform Site maintenance, to dewater the Site and to restore erosion control facilities before resuming work.
 - 5) Where the Contractor can demonstrate that the abnormal weather event has impaired his ability to perform work, beyond the day of the abnormal event, a recovery day, or days, to perform Site maintenance as necessary to restore the Site to a workable condition will be awarded. The recovery days may be awarded if requested in writing by the Contractor and approved by the Engineer. Written requests for recovery days shall include a description of Work activities performed during the recovery days.

ARTICLE 5 – SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

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

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

Report Title	Date of Report	Technical Data
Geotechnical Evaluation Green Canyon Water Treatment Plant Chlorine Contact Tank	March 11, 2024	Geotechnical Evaluation

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

Drawings Title	Date of Drawings	Technical Data
Green Canyon Water Treatment Facility	1986	Construction Drawings (Record Drawings)

- G. Contractor may examine copies of reports and drawings identified in SC 5.03.E and SC 5.03.F that were not included with the Bidding Documents at location identified in the Contract Documents, or may request copies from Engineer. Contractor shall be responsible for reproduction costs if requested.

SC 5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

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

Report Title	Date of Report	Technical Data
None	N/A	None

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

Drawings Title	Date of Drawings	Technical Data
None	N/A	None

ARTICLE 6 – BONDS AND INSURANCE

6.03 Contractor's Insurance

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

- D. 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

Workers' Compensation and Related Policies	Policy limits of not less than:
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory
Employer's Liability	
Each accident	[\$1,000,000]
Each employee	[\$500,000]
Policy limit	[\$1,000,000]

- E. 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.
- F. 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.
- G. 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.
- H. Commercial General Liability—Minimum Policy Limits

Commercial General Liability	Policy limits of not less than:
General Aggregate	\$[2,000,000]
Bodily Injury and Property Damage—Each Occurrence	\$[500,000]

- I. 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	\$[5,000,000]
Property Damage	
Each Accident	\$[5,000,000]

- J. Using Umbrella or Excess Liability Insurance to Meet CGL and Other Policy Limit Requirements: Contractor may meet the policy limits specified for employer’s liability, commercial general liability, and automobile liability through the primary policies alone, or through combinations of the primary insurance policy’s policy limits and partial attribution of the policy limits of an umbrella or excess liability policy that is at least as broad in coverage as that of the underlying policy, as specified herein. If such umbrella or excess liability policy was required under this Contract, at a specified minimum policy limit, such umbrella or excess policy must retain a minimum limit of \$5,000,000 after accounting for partial attribution of its limits to underlying policies, as allowed above.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC 7.10 Add a new paragraph immediately after Paragraph 7.10.A:

- B. Owner is exempt from payment of sales and compensating use taxes of the State of Utah and of cities and counties thereof on all materials to be incorporated into the Work.
1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the Work.
 2. Owner’s exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

SC 7.11 Delete last sentence of Paragraph 7.11.B and replace with the following:

“If Contractor observes that the Contract Documents are at variance with any Laws or Regulations, Contractor shall give Engineer prompt written notice of variance. If Contractor performs any Work knowing it to be contrary to such

Laws or Regulations, and without such notice to Engineer, Contractor shall bear all costs arising.

ARTICLE 8 – OTHER WORK AT THE SITE

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 9 – OWNER'S RESPONSIBILITIES

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION

SC 10.03 Add the following new paragraphs immediately after Paragraph 10.03.B:

- C. The Resident Project Representative (RPR) will be Engineer's representative at the Site. RPR's dealings in matters pertaining to the Work in general will be with Engineer and Contractor. RPR's dealings with Subcontractors will only be through or with the full knowledge or approval of Contractor. The RPR will:
1. Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings (but not including Contractor's safety meetings), and as appropriate prepare and circulate copies of minutes thereof.
 2. Safety Compliance: Comply with Site safety programs, as they apply to RPR, and if required to do so by such safety programs, receive safety training specifically related to RPR's own personal safety while at the Site.
 3. Liaison
 - a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for Contractor's proper execution of the Work.

4. Review of Work; Defective Work
 - a. Conduct on-Site observations of the Work to assist Engineer in determining, to the extent set forth in Paragraph 10.02, if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Observe whether any Work in place appears to be defective.
 - c. Observe whether any Work in place should be uncovered for observation, or requires special testing, inspection or approval.
5. Inspections and Tests
 - a. Observe Contractor-arranged inspections required by Laws and Regulations, including but not limited to those performed by public or other agencies having jurisdiction over the Work.
 - b. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Work.
6. Payment Requests: Review Applications for Payment with Contractor.
7. Completion
 - a. Participate in Engineer's visits regarding Substantial Completion.
 - b. Assist in the preparation of a punch list of items to be completed or corrected.
 - c. Participate in Engineer's visit to the Site in the company of Owner and Contractor regarding completion of the Work, and prepare a final punch list of items to be completed or corrected by Contractor.
 - d. Observe whether items on the final punch list have been completed or corrected.

D. The RPR will not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.
4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction.
5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.
6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
7. Authorize Owner to occupy the Project in whole or in part.

ARTICLE 11 – CHANGES TO THE CONTRACT

No modifications to the General Conditions via this Article of the Supplementary Conditions.

SC 11.07 Add the following new paragraph immediately after Paragraph 11.07.C.2:

3. Additional Contractor overhead costs due to delays beyond the control of Contractor, as provided in Paragraph 4.05, shall not be allowed except under the following conditions:
 - a. Contract Time extension beyond original Agreement.
 - b. Contract Time extension beyond previously approved changes in Contract Time and associated overhead costs.

ARTICLE 12 – CLAIMS

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 13 – COST OF THE WORK; CASH ALLOWANCES, UNIT PRICE WORK

SC 13.01 Amend the first sentence of Paragraph 13.01.B.4. by striking out the following words:

(including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants)

And replace with the following words:

(including but not limited to engineers, architects, testing laboratories, and surveyors)

SC 13.01 Delete Paragraph 13.01.B.5.a in its entirety and insert the following in its place:

a. Not used.

SC 13.01 Supplement Paragraph 13.01.B.5.c.(2) by adding the following sentence:

The equipment rental rate book that governs the included costs for the rental of machinery and equipment owned by Contractor (or a related entity) under the Cost of the Work provisions of this Contract is the most current edition of Rental Rate Blue Book.

SC 13.01 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 any tool or equipment whose current price if it were purchased new at retail would be less than \$500.

SC 13.01 Add the following new paragraph immediately after Paragraph 13.01.C.7.

8. Claims for extra costs based on material or labor cost escalation through the duration of the Contract.

SC 13.03 Delete Paragraph 13.03.E in its entirety and insert the following in its place:

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 variation in the quantity of a particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 20 percent 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 15 percent as a result of the quantity change. Contractor shall provide documentation and information to substantiate unit cost change as specified in the Contract Documents.

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

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 15 – PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETION; CORRECTION PERIOD

SC 15.01 Add the following new subparagraph immediately after Paragraph 15.01.A.

1. Contractor shall submit the Schedule of Values as specified in Article 2.0 for review and acceptance by Owner and Engineer. Schedule of Values shall be modified and corrected as directed by Owner and Engineer and as specified in the Contract Documents. Schedule of Values will be used as basis of preparing Application for Payment and progress payments.

SC 15.01 Delete Paragraph 15.01.B.4 in its entirety and insert the following in its place:

4. Application for Payment request shall include the percentage of the total amount of the Contract which has been completed from the start-up of the Project to and including the last day of the preceding month, or other mutually agreed upon day of the month accompanied by such data and supporting evidence as Owner or Engineer may require.

SC 15.01 Add the following new paragraph immediately after Paragraph 15.01.B.4:

5. Application for Payment forms shall be prepared by Contractor and accepted by Owner and Engineer prior to first Application for Payment.

SC 15.01 Add the following new paragraph immediately after Paragraph 15.01.B.5:

6. Retainage
 - a. Owner will retain ten percent (10%) of the amount of each such estimate until Work covered by the Contract is fifty percent (50%) complete.
 - b. After fifty percent (50%) of the Work of the original Contract has been completed as evidenced by approved Application for Payment exclusive of stored materials and in the opinion of the Owner, satisfactory progress

is being made, the Owner may adjust future Application for Payments so that five percent (5%) of the original Contract Price is retained.

- c. If the Owner determines it is appropriate to reduce retainage, the method used for such adjustment shall be to fix retainage at five percent (5%) of the original Contract amount (when the work is 50% complete) and to pay all subsequent Application for Payments to the full approved amount. The intent of such an adjustment is to gradually reduce retainage to five percent (5%) of the original Contract amount when the Work is one hundred percent (100%) complete.
- d. Owner may reinstate up to ten percent (10%) retainage if it is determined that the Contractor is not making satisfactory progress or there is other specific cause for such retainage.]

SC 15.01 Amend the first sentence of Paragraph 15.01.C.1 by striking out the following words:

“10 days”

And replace with the following:

“30 days”

SC 15.01 Amend the first sentence of Paragraph 15.01.D.1 by striking out the following words:

“Ten days”

And replace with the following:

“Thirty days”

SC 15.01 Amend Paragraph 15.01.E.3 by striking out the following words:

“as provided in the Agreement”

And replace with the following:

“equal to the federal funds rate as established by the Federal Open Market Committee of the United States Federal Reserve.”

SC 15.03 Amend Paragraph 15.03.C by striking out the following words in the third sentence:

“7 days”

And replace with the following:

“14 days”

SC 15.03 Amend Paragraph 15.03.C by striking out the following words located in the fourth and fifth sentences (two places total):

“14 days”

And replace with the following:

“21 days”

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

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

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

No modifications to the General Conditions via this Article of the Supplementary Conditions.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

No modifications to the General Conditions via this Article of the Supplementary Conditions.

SC 17.01 Add the following new paragraph immediately after Paragraph 17.01.B.1:

- a. If required by applicable Laws and Regulations, and not specifically excluded elsewhere, either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Article 12 before such decision becomes final and binding.

SC 17.02 Add the following new paragraph immediately after Paragraph 17.01:

17.02 Arbitration

- A. All matters subject to final resolution under this Article will be settled by arbitration administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules (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 sent to Engineer for information. The demand for arbitration will be made within the specific time required in Article 17, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event will any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations.
- C. The arbitrator(s) must be licensed engineers, contractors, attorneys, or construction managers. Hearings will take place pursuant to the standard procedures of the Construction Arbitration Rules that contemplate in-person hearings. The arbitrators will have no authority to award punitive or other damages not measured by the prevailing party's actual damages, except as may be required by statute or the Contract. Any award in an arbitration initiated under this clause will be limited to monetary damages and include no injunction or direction to any party other than the direction to pay a monetary amount.
- D. The Arbitrators will have the authority to allocate the costs of the arbitration process among the parties, but will only have the authority to allocate attorneys' fees if a specific Law or Regulation or this Contract permits them to do so.
- E. The award of the arbitrators must be accompanied by a reasoned written opinion and a concise breakdown of the award. The written opinion will cite the Contract provisions deemed applicable and relied on in making the award.
- F. The parties agree that failure or refusal of a party to pay its required share of the deposits for arbitrator compensation or administrative charges will constitute a waiver by that party to present evidence or cross-examine witness. In such event, the other party shall be required to present evidence and legal argument as the arbitrator(s) may require for the making of an award. Such waiver will not allow for a default judgment against the non-paying party in the absence of evidence presented as provided for above.
- G. No arbitration arising out of or relating to the Contract will include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:

1. the inclusion of such other individual or entity will allow complete relief to be afforded among those who are already parties to the arbitration;
 2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration, and which will arise in such proceedings;
 3. such other individual or entity is subject to arbitration under a contract with either Owner or Contractor, or consents to being joined in the arbitration; and
 4. the consolidation or joinder is in compliance with the arbitration administrator's procedural rules.
- H. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.
- I. Except as may be required by Laws or Regulations, neither party nor an arbitrator may disclose the existence, content, or results of any arbitration hereunder without the prior written consent of both parties, with the exception of any disclosure required by Laws and Regulations or the Contract. To the extent any disclosure is allowed pursuant to the exception, the disclosure must be strictly and narrowly limited to maintain confidentiality to the extent possible.

SC 17.03 Add the following new paragraph immediately after Paragraph 17.02:

- A. Attorneys' Fees: 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

ARTICLE 18 – MISCELLANEOUS

No modifications to the General Conditions via this Article of the Supplementary Conditions.

END OF SECTION

SECTION 01 11 00
SUMMARY OF WORK

PART 1 –
GENERAL

1.01 SUMMARY

A. Section Includes:

1. Summary
2. Location and Description of Work
3. Construction Contracts, This Project
4. Construction Contracts, Other Projects (NOT USED)
5. Work by Others (NOT USED)
6. Work by Owner
7. Owner Furnished Equipment and Materials (NOT USED)
8. Owner Assigned Procurement Contracts (NOT USED)
9. Owner Pre-selected Equipment and Materials (NOT USED)
10. Sequence and Progress of Work
11. Contractor's Use of Site
12. Easements and Rights-of-Way
13. Notices to Owners and Authorities of Properties Adjacent to the Work
14. Salvage of Equipment and Materials
15. Partial Utilization by Owner

1.02 LOCATION AND DESCRIPTION OF WORK

- A. The Work is located at the following Site:
 - 1. Green Canyon Water Treatment Plant located at the mouth of Green Canyon in North Logan City. The plant's approximate address is 1876 Green Canyon Drive, North Logan, UT 84341

- B. The Work to be performed under this Contract includes, but is not limited to, constructing the Work described below and all appurtenances related to the Work. The Work shall be as follows:
 - 1. Construction of a new buried concrete disinfection contact basin
 - 2. Replacement of existing electrical panel to sub feed a new sub-panel.
 - 3. Replacement of chlorine dosing equipment
 - 4. Construction of a new concrete vault with flowmeter and valves
 - 5. Connection to existing piping for the new basin

1.03 CONSTRUCTION CONTRACTS, THIS PROJECT

- A. The Contracts under which the Project will be constructed are:
 - 1. Work specified in Divisions 01 through 46 (inclusive) of the Specifications.
 - 2. Work shown on sheets 1 through 41 (inclusive) of the Drawings.

1.04 CONSTRUCTION CONTRACTS, OTHER PROJECTS (NOT USED)

1.05 WORK BY OTHERS (NOT USED)

1.06 WORK BY OWNER

- A. Owner will perform the following in connection with the Work: Operate all existing valves, gates, pumps, equipment, and appurtenances that will affect Owner's operation, unless otherwise specified or indicated.

1.07 OWNER-FURNISHED EQUIPMENT AND MATERIALS (NOT USED)

1.08 OWNER ASSIGNED PROCUREMENT DOCUMENTS (NOT USED)

1.09 OWNER PRE-SELECTED EQUIPMENT AND MATERIALS (NOT USED)

1.10 SEQUENCE AND PROGRESS OF WORK

- A. Requirements for sequencing and coordinating with Owner's operations, including maintenance of plant operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 00 – Coordination with Owner's Operations.

1.11 CONTRACTOR'S USE OF SITE

- A. Contractors' use of the Site shall be confined to the areas shown. Contractors shall share use of the Site with other contractors and others specified in this Section.
- B. Contractor shall move stored products that interfere with operations of Owner, other contractors, or others performing work for Owner.

1.12 EASEMENTS AND RIGHTS-OF-WAY

- A. Easements and rights-of-way will be provided by Owner in accordance with the General Conditions. Confine construction operations to within Owner's property, public rights-of-way, easements obtained by Owner, and the limits shown. Use care in placing construction tools, equipment, excavated materials, and products to be incorporated into the Work to avoid damaging property and interfering with traffic. Do not enter private property outside the construction limits without permission from the owner of the property.

1.13 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

- A. Notify owners of adjacent property and utilities when execution of the Work may affect their property, facilities, or use of property.
- B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Conform notices to Laws and Regulations and, whether delivered orally or in writing, include appropriate information concerning the interruption and instructions on how to limit inconvenience caused.
- C. Notify utility owners and other concerned entities at least 48 hours prior to cutting or closing streets or other traffic areas or excavating near Underground Facilities or exposed utilities.

1.14 SALVAGE OF EQUIPMENT AND MATERIALS

- A. Existing equipment and materials removed and not shown or specified to be reused in the Work will be Contractor's property, except the following items that shall remain Owner's property:
 - 1. NONE.
- B. Existing equipment and material removed by Contractor shall not be reused in the Work, except where specified or indicated.
- C. Carefully remove in manner to prevent damage all equipment and materials specified or indicated to be salvaged and reused or to remain property of Owner. Store and protect salvaged items specified or indicated to be used in the Work. Replace in kind or with new items equipment, materials, and components damaged in removal, storage, or handling through carelessness or improper procedures.
- D. Contractor may furnish and install new items, with Engineer's approval, instead of those specified or indicated to be salvaged and reused, in which case such removed items will become Contractor's property.

1.15 PARTIAL UTILIZATION BY OWNER

- A. Owner reserves the right to enter and use portions of the Work prior to Certificate of Substantial Completion is issued by Engineer.
- B. Owner shall be responsible to prevent premature connections by private and public parties, persons or groups of persons, before Engineer issues Certificate of Substantial Completion for the portion of Work being partially utilized by Owner.
- C. Contractor shall cooperate with Owner, Owner's agents, and Engineer to accelerate completion of Work designed for partial utilization by Owner in accordance with Contractor's progress schedule.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00
COORDINATION WITH OWNER'S OPERATIONS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for coordinating with Owner's operations during the Work and included requirements for tie-ins and shutdowns necessary to complete the Work without impact on Owner's operations except as allowed in this Section.
2. Contractor shall provide labor, materials, tools, equipment and incidentals shown, specified and required to coordinate with Owner's operations during the Work.

B. General Requirements:

1. Except for shutdowns specified in this Section, perform the Work such that Owner's facility remains in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede Owner's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, or cause odors or other nuisances.
2. Work not specifically covered in this Section or in referenced Sections may, in general, be completed at any time during regular working hours in accordance with the General Conditions and Supplementary Conditions, subject to the requirements in this Section.
3. Contractor has the option of providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to Owner, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect Owner's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

4. Coordinate shutdowns with Owner and Engineer. When possible, combine multiple tie-ins into a single shutdown to minimize impacts on Owner's operations and processes.
5. Do not shut off or disconnect existing operating systems, unless accepted by Engineer in writing. Operation of existing equipment will be by Owner unless otherwise specified or indicated. Where necessary for the Work, Contractor shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both. Provide temporary watertight plugs, bulkheads, and line stops as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Engineer.

C. Continuous Treatment Provision:

1. Federal regulations prohibit bypassing of untreated or partially treated wastewater or sewage during construction Work.
2. Contractor shall provide labor, equipment, materials, and incidentals to provide continuous treatment to the level prior to construction Work.
3. Contractor shall be responsible for providing temporary pumping facilities, systems, piping, valve, appurtenances, equipment, materials, and temporary utilities necessary to complete the Work without treatment bypassing.

D. Related Sections:

1. Section 01 11 00 – Summary of Work
2. Section 01 25 00 – Substitution Procedures

1.02 REFERENCES

- A. Definitions: A "shutdown" is when a portion of the normal operation of Owner's facility, whether equipment, systems, piping, or conduit, has to be temporarily suspended or taken out of service to perform the Work.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review installation procedures under other Specification sections and coordinate Work that must be performed with or before the Work specified in this Section.
2. Notify other contractors in advance of Work requiring coordination with Owner's operations, to provide other contractors sufficient time for work included in their contracts that must be installed with or before Work specified in this Section.

3. When possible, combine multiple tie-ins into a single shutdown to minimize impacts on Owner's operations and processes.
- B. Pre-Shutdown Meetings: Contractor shall schedule and conduct meeting with Owner and Engineer prior to scheduling shutdown
- C. Sequencing:
1. Perform the Work in the specified sequence. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed sequence change, with Engineer's acceptance. Stages specified in this Section are sequential in performance of the Work.
- D. Scheduling:
1. Work that may interrupt normal operations shall be accomplished at times convenient to Owner.
 2. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, equipment, spare parts and materials, both temporary and permanent, necessary to successfully complete the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with these requirements before commencing the shutdown.
 3. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.
 4. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not conform to the requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in conducting the Work.
 5. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.
 6. Temporary, short-term shutdowns of smaller piping, conduits, equipment, and systems may be required. Coordinate requirements for such shutdowns with Engineer and Owner.

1.04 SUBMITTALS

- A. Action/Informational Submittals:

1. **Substitute Sequence Submittal:** When deviation from specified sequence is proposed, provide submittal explaining in detail the proposed sequence change and its effects, including evidence that Owner's operations will not be adversely affected by proposed change. List benefits of proposed sequence change, including benefits to Progress Schedule. Submit in accordance with Section 01 25 00 – Substitution Procedures.
2. **Shutdown Planning Submittal:**
 - a. For each shutdown, submit an inventory of labor and materials required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
 - b. Furnish submittal to Engineer at least thirty (30) days prior to proposed shutdown start date. Do not start shutdown until obtaining Engineer's acceptance of shutdown planning submittal.
3. **Shutdown Notification:** After acceptance of shutdown planning submittal and prior to starting the shutdown, provide written notification to Owner and Engineer of date and time each shutdown is to start. Provide notification at least 72 hours in advance of each shutdown.

1.05 SITE CONDITIONS

- A. **General Constraints:** Specified in the Contract Documents are the sequence and shutdown durations, where applicable, for Owner's equipment, systems, and conduits that are to be taken out of service temporarily for the Work. New equipment, materials, and systems may be used by Owner after the specified field quality controls and testing are successfully completed and the materials or equipment are Substantially Complete.
- B. The following constraints apply to coordination with Owner's operations:
 1. **Operational Access:** Owner's personnel shall have access to equipment and areas that remain in operation.
 2. **Schedule and perform equipment and system start-ups** for Monday through Thursday. Equipment and systems shall not be placed into operation on Friday, Saturday, and Sunday without prior approval of Owner.
 3. **Dead End Valves or Pipe:** Provide blind flanges, watertight bulkheads, or valves at temporary and permanent terminuses of pipes and conduits. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as directed by Engineer. Temporary valves shall be suitable

for their associated service. Where valve is provided at permanent terminus of pipe or conduit, also provide on downstream side of valve a blind flange with drain/flushing connection.

4. Owner will assist Contractor in dewatering process tanks, basins, conduits, and other work areas to be dewatered for shutdowns. Maintain clean and dry work area by pumping and properly disposing of fluid that accumulates in work areas.
5. Draining and Cleaning of Conduits, Tanks, and Basins: Unless otherwise specified, Owner will dewater process tanks and basins at beginning of each shutdown. Owner will flush and wash down tanks and basins with plant non-potable water. Draining and cleaning conducted by Contractor shall be as specified below:
 - a. Contractor shall remove liquids and solids and dispose of them at appropriate location at the Site as directed by Engineer. Contents of pipes, tanks, basins, and conduits undergoing modifications shall be transferred to existing process tanks or conduits at the Site with capacity sufficient to accept such discharges, using hoses, piping, pumps, or other means provided by Contractor. Discharge of fluids across floors is not allowed.
 - b. If drainage point is not available on the piping or conduit to be drained, provide a wet tap using tapping saddle and valve or other method approved by Engineer. Uncontrolled spillage of pipe's or conduit's contents is not allowed.
 - c. Spillage shall be brought to Engineer's attention immediately, both verbally and in writing, and reported in accordance with Laws and Regulations. Contractor shall wash down spillage to floor drains or sumps and flush the system to prevent clogging and odors. If spillage is not suitable for discharge to the drainage system, such as chemical spills, as determined by Engineer, Contractor shall remove spillage by other method, such as vactor truck, acceptable to Engineer.
6. Electrical, Control, Communication, and Monitoring Systems:
 - a. Owner's existing SCADA system and fiber optic network shall remain functional, subject to the constraints herein.
 - b. Ethernet communications and network connectivity to the Treatment Plant Building, tank mixers, and the Booster Pump Station shall remain operational during the hours of 7:00AM and 5:00PM Monday-Friday.
 - c. Unless Contractor elects to use existing fiber and/or temporary fiber, at his/her discretion, at least one communication path through the new dual

redundant fiber optic ring to all communication points shall be in place at all times until substantial completion.

- d. Each process area shall be permitted to have a single, non-concurrent, scheduled outage for the purpose of making PLC panel hardware modifications, loading the associated PLC logic, and its field testing/demonstration. Field testing and demonstration shall immediately follow modifications in an effort to keep scheduled shutdowns as short as possible. A 14-day day period of no SCADA outage shall proceed each scheduled shutdown.

1.06 SUGGESTED SEQUENCE OF WORK

- A. Perform the Work in the specified sequence or as otherwise approved by Engineer. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed sequence change, and with Engineer's acceptance. Stages specified in this Section are sequence-dependent.
 - 1. Stage 1: Potholing and utility locating
 - 2. Stage 2: Excavation
 - 3. Stage 3: Disinfection Contact Basin Construction
 - 4. Stage 4: Electrical and Chlorine Dosing Improvements

1.07 TIE-INS

- A. Table 01 14 00-A in this Section lists connections by Contractor to existing facilities. Table 01 14 00-A may not include all tie-ins required for the Work; Contractor shall perform tie-ins required to complete the Work. For tie-ins not included in Table 01 14 00-A, obtain requirements for tie-ins from Engineer.

1.08 SHUTDOWNS

- A. General:
 - 1. Work that may interrupt normal operations shall be accomplished at times convenient to Owner.
 - 2. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, equipment, spare parts and materials, both temporary and permanent, necessary to successfully complete the shutdown. Complete to the extent possible,

prefabrication of piping and other assemblies prior to the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with these requirements before commencing the shutdown.

3. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.
4. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not conform to the requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in conducting the Work.
5. Shutdowns shall be in accordance with Table 01 14 00-B of this Section. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.
6. Temporary, short-term shutdowns of smaller piping, conduits, equipment, and systems may not be included in Table 01 14 00-B. Coordinate requirements for such shutdowns with Engineer and Owner.

B. Treatment Process Shutdown and Site Access Constraints:

1. Owner shall have the following unit processes and equipment operational at all times during the Project, unless specified herein:
 - a. Booster Pumps: Two (in pump station below existing storage tanks)
2. Owner shall have roadway access to all areas throughout the course of construction

C. Shutdowns of Electrical Systems: Comply with Laws and Regulations, including the National Electric Code. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before shutdown Work is started. Upon completion of shutdown Work, remove the locks and tags and notify Engineer that facilities are available for use.

D. Shutdowns of Communications, SCADA, and Networking:

1. Permissible SCADA outages include when the plant can be shutdown as coordinated with OWNER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 GENERAL

- A. Refer to Table 01 14 00-B in this Section for schedule of process equipment and service lines out-of-service during shutdown.
- B. Refer to Table 01 14 00-B in this Section for schedule of process equipment in operation during shutdown.
- C. Refer to Table 01 14 00-B in this Section for tie-ins required during each shutdown. Refer to Table 01 14 00-A in this Section for detailed tie-in schedule.
- D. Refer to Table 01 14 00-B in this Section for duration of each shutdown.

3.02 DETAILED SHUTDOWN REQUIREMENTS:

- A. Prior to Typical Shutdown:
 - 1. Obtain Engineer's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
 - 2. Submittal and approval of all shop drawings required.
 - 3. Coordinate with plant operations on timing of shutdown and provide required notice to Owner.
 - 4. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
 - 5. Assist Owner in preparing to take equipment, tanks, basins, and conduits temporarily out of service.
 - 6. Coordinate other tie-ins to be performed simultaneously.
 - 7. Install and ensure functionality of temporary systems as applicable.
- B. During Typical Shutdown:
 - 1. Owner will dewater tanks and basins.
 - 2. Remove existing equipment, piping, and accessories as required.
 - 3. Verify operation of new equipment, materials, and systems.

4. Following approval from Engineer, return equipment and system to operation with Owner.

C. Following Typical Shutdown:

1. Verify functionality of equipment and system.
2. Verify operation of new equipment and systems and verify that joints in piping are watertight or gastight as applicable.
3. Repair joints that are not watertight or gastight as applicable.
4. Remove temporary systems as applicable.

3.03 PROPOSED SHUTDOWN SEQUENCE

A. Shutdown No. 1 Description: Temporary Disconnect 6" Finished Water Pipe

1. General:
 - a. Impact on Other Equipment and Processes: Wells 1 and 2 shutdown
 - b. Location: Yard near 1MG storage reservoir
 - c. Owner access to Site roadways: Limited
2. Prior to Shutdown:
 - a. Obtain Engineer's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
 - b. Assist Owner in preparing to take equipment, tanks, and basins temporarily out of service.
 - c. Specific requirements: Ensure piping, valves and fittings are disinfected prior to making connections.
3. During Shutdown:
 - a. Installation of remaining Work required.
 - b. 1MG storage tank will not be drained for this shutdown. Install valve in line that is filled with water.
 - c. Verify water tightness of new valves and fittings
4. Following shutdown:

- a. Refer to Section 3.03.C for following typical shutdowns.
- B. Shutdown No. 2 Description: Tie in new Disinfection Contact Basin
- 1. General:
 - a. Impact on Other Equipment and Processes: Entire plant shutdown
 - b. Location: Disinfection Contact Basin
 - c. Owner access to Site roadways: Limited
 - 2. Prior to Shutdown:
 - a. Obtain Engineer's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
 - b. Assist Owner in preparing to take equipment, tanks, basins, and conduits temporarily out of service.
 - c. Specific requirements: Ensure tank and piping are disinfected prior to making connection.
 - 3. During Shutdown:
 - a. Installation of remaining Work required.
 - b. Perform tie-ins shown on Table 01 14 00-B.
 - c. Verify functionality of equipment and system.
 - 4. Following shutdown:
 - a. Refer to Section 3.03.C for following typical shutdowns.
- C. Shutdown No. 3 Description: Chlorine dosing equipment replacement.
- 1. General:
 - a. Impact on Other Equipment and Processes: Entire plant shutdown
 - b. Location: Chlorine Room
 - c. Owner access to Site roadways: Full
 - 2. Prior to Shutdown:

- a. Obtain Engineer's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
 - b. Assist Owner in preparing to take equipment, tanks, basins, and conduits temporarily out of service.
 - c. Specific requirements: None
3. During Shutdown:
- a. Installation of remaining Work required.
 - b. Replace existing equipment.
 - c. Verify functionality of equipment and system.
4. Following shutdown:
- a. Refer to Section 3.03.C for following typical shutdowns.

**Table 01 14 00-A
Schedule of Tie-Ins**

Tie-In No.	New Line Size and Service	Existing (Connecting) Line Size & Service	Tie-In Building/Location	Construction Stage	Remarks
1	12" DCB Influent	12" Final Effluent	Road shoulder near DCB	1	N/A
2	12" DCB Effluent	12" Final Effluent	Road shoulder near DCB	1	N/A

**Table 01 14 00-B
Schedule of Shutdowns**

Shutdown No.	Process Equipment and Service Lines Out-of-Service During Shutdown	Process Equipment In Operation During Shutdown	Tie-In Nos.	Maximum Duration
1	Wells 1 & 2	Storage Tanks		2 days
2	Entire Plant	None	1,2,3	5 days
3	Entire Plant	None		1 day

END OF SECTION

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SECTION 01 20 00
MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Items listed in this Section refer to and are the same pay items listed in the Bid Form and constitute all pay items for completing the Work.
2. Compensation for all services, items, materials, and equipment shall be include in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.
3. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, bonds, insurance, or other requirements of the General Conditions, Supplementary Conditions, General Requirements, and other requirements of the Contract Documents.
4. Each lump sum and unit bid price shall include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

B. Related Sections:

1. Payments to Contractor: Refer to General Conditions, Supplementary Conditions, and Agreement.
2. Changes to Contract Price: Refer to General Conditions, Supplementary Conditions, and Section 01 26 00 – Contract Modification Procedures.
3. Schedule of Values: Refer to General Conditions, Supplementary Conditions, and Section 01 29 73 – Schedule of Values.

1.02 ENGINEER'S ESTIMATE OF QUANTITIES

- A. ENGINEER'S and OWNER's estimated quantities for unit price pay items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. Owner does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground or the actual quantities of material encountered or required will correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity as Owner may deem necessary. Contractor will not be entitled to any adjustment in a unit bid price as a result

of any change in an estimated quantity and agrees to accept the aforesaid unit bid prices as complete and total compensation for any additions caused by changes or alterations in the Work ordered by Owner.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Contractor shall include all additional Work items, services, goods, resources, and manpower necessary for installation of the Work to provide a completely functional system in accordance with the Contract Documents. Contractor shall include these costs associated with providing a completely functional system within the listed items on the Bid Form and as specified herein.

- B. Bid Items:
 - 1. Item 1: Mobilization:
 - a. Measurement and Payment: Lump sum for Item 1 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.

 - 2. Item 2: General Temporary Fencing:
 - a. Measurement and Payment: Payment shall be per linear foot of temporary fencing installed

 - 3. Item 3: General – Utilities Location and Marking
 - a. Measurement and Payment: Lump sum for Item 3 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.

 - 4. Item 4: General – Potholing
 - a. Measurement and Payment: Payment shall be per each pothole required.

 - 5. Item 5: General – Temporary Relocation Of 6-Inch Well Water Line (Including Valves and Caps)
 - a. Measurement and Payment: Lump sum for Item 5 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.

6. Item 6: Civil - Excavation
 - a. Measurement and Payment: Payment shall be per cubic yard, which includes excavation, placement of engineered fill, and compaction of engineered fill. The quantity of additional excavation and replacement to be paid for shall be the actual quantity of cubic yards of excavated material that has been removed and replaced with the new structure or structural fill as indicated on the Drawings, as specified, and directed by Owner.
7. Item 7: Hauling and Disposing Spoils
 - a. Measurement and Payment: Payment shall be per cubic yard, which includes hauling and disposal of unusable material. The quantity of additional hauling and disposal to be paid for shall be the actual quantity of cubic yards of excavated material that has been removed as indicated on the Drawings, as specified, and directed by Owner.
8. Item 8: Shoring
 - a. Measurement and Payment: Lump sum for Item 8 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
9. Item 9: Yard Piping and Vault
 - a. Measurement and Payment: Lump sum for Item 9 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
10. Item 10: Final Grading
 - a. Measurement and Payment: Payment shall be per cubic yard, which includes rough and final grading. The quantity of grading to be paid for shall be the actual quantity of cubic yards of graded material that has been placed as indicated on the Drawings, as specified, and directed by Owner.
11. Item 11: Disinfection Contact Basin
 - a. Measurement and Payment: Lump sum for Item 11 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
12. Item 12: Sample Pump, Piping, Chlorine Analyzer, Misc Valves, and Fittings

- a. Measurement and Payment: Lump sum for Item 12 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
- 13. Item 13: Chlorinator
 - a. Measurement and Payment: Lump sum for Item 13 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
- 14. Item 14: Panel Replacement, New Conduit, and New Panel
 - a. Measurement and Payment: Lump sum for Item 15 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
- 15. Item 15: All Other Elements of the Work not Included in Other Items as it Pertains to the Contract Documents.
 - a. Measurement and Payment: Lump sum for Item 15 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.
- 16. Item 16: 3" Pavement Restoration/Repair
 - a. Measurement and Payment: Payment shall be per square foot of pavement repair or replacement installed.
- 17. Item 17: Startup and Demobilization
 - a. Measurement and Payment: Lump sum for Item 17 will be full compensation for administration and completion of the Work, as shown on the Drawings and specified in the Contract Documents, except Work specifically included under other Items.

C. Alternate Bid Items:

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Procedural requirements for product substitutions.
 - 2. Procedural requirements for substitute construction methods or procedures, when construction methods or procedures are specified.
- B. Requests for substitutions of equipment and material shall conform to the requirements of the General Conditions and Supplemental Conditions.
- C. Procedure for substitution requests and review including evaluation, reimbursement, acceptance, and determination shall be in accordance with General Conditions and Supplemental Conditions.

1.02 REFERENCES

- A. Definitions: The following words or terms are not defined but, when used in this Section, have the following meaning:
 - 1. “Acceptable Manufacturers” considered for substitution include Suppliers of equipment and material of proven reliability, and as manufactured by reputable manufacturers having experience in the production of specified equipment and material. Equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed in accordance with the Contract Documents.
 - 2. “Products” includes materials, equipment, machinery, components, fixtures, systems, and other goods incorporated in the Work. Products do not include machinery and equipment used for preparing, fabricating, conveying, erecting, or installing the Work. Products include Owner-furnished goods incorporated in the Work where use of such goods is specifically required in the Contract Documents.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Contractor’s Responsibilities: In submitting request for substitution, Contractor represents that:
 - 1. Contractor has investigated proposed substitution and determined that it is equivalent to item, product, method, or procedure specified, as applicable.

2. Contractor will provide the same or better guarantees or warranties for proposed substitution as for the specified product, manufacturer, method, or procedure, as applicable.
 3. Contractor waives all Claims for additional costs or extension of time related to proposed substitution that subsequently may become apparent.
 4. Contractor shall submit a minimum of five (5) successful installations of the manufacturer's equipment of the same model, size, and type as specified in the Contract Documents.
 5. All costs associated with incorporation of a substitution shall be borne by the Contractor, including but not limited to, the cost of redesign and construction provisions.
- B. Engineer's Review: A proposed substitution will not be accepted for review if:
1. Approval would require changes in design concept or a substantial revision of the Contract Documents.
 2. Approval would delay completion of the Work or the work of other contractors.
 3. Substitution request is indicated or implied on a Shop Drawing or other submittal, or on a request for interpretation or clarification, and is not accompanied by Contractor's formal request for substitution.
 4. If the substitution is not clearly substantiated by performance criteria as providing an equivalent or superior performing installation.
 5. All costs associated with Engineer's review of a substitution shall be recorded by Engineer, submitted to Owner, and charged to Contractor.
- C. If Engineer does not approve the proposed substitute, Contractor shall provide the specified product, manufacturer, method, or procedure, as applicable.
- D. Approval of a substitution request will not relieve Contractor from requirement for submitting Shop Drawings as set forth in the Contract Documents.
- E. Product Substitutions Procedure:
1. Requests for approval of substitute products or items will be considered for a period of 30 days after the Effective Date of the Agreement. After end of specified period, requests will be considered only in case of unavailability of a specified product or other conditions beyond Contractor's control.
 2. Submit copies of request for substitution.
 3. Submit separate request for each substitution.

4. In addition to requirements of the General Conditions and information required on substitution request forms, include with request the following:
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature with product description, performance and test data, and reference standards with which product complies.
 - c. Samples, if appropriate.
 - d. Name and address of similar projects on which product was used, and date of installation.
 - e. Certified tests, where applicable, by an independent laboratory attesting the proposed substitution is equal.
 - f. Cost information for the proposed substitution and the specified products.
 - g. Lead time information for the proposed substitution and specified products.
 - h. All other submittal requirements indicated in the individual Specification Sections associated with the specified equipment and material.

F. Construction Methods Substitutions Procedures:

1. Where construction methods or procedures are specified, for a period of 30 days after the Effective Date of the Agreement, Engineer will consider Contractor's written requests for substitute construction methods or procedures specified.
2. Submit copies of request for substitution.
3. Submit separate request for each substitution.
4. In addition to requirements of the General Conditions and information required on substitution request forms, include with request the following:
 - a. Detailed description of proposed method or procedure.
 - b. Itemized comparison of the proposed substitution with the specified method or procedure.
 - c. Drawings illustrating method or procedure.
 - d. Other data required by Engineer to establish that proposed substitution is equivalent to specified method or procedure.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Section Includes:

1. General Conditions and Supplementary Conditions provision expansion, including the following:
 - a. Requests for interpretation.
 - b. Field Orders
 - c. Work Change Directives
 - d. Proposal requests
 - e. Change Proposals
 - f. Change Orders

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Submit Contract modification documents to Engineer's contact person and address in the Contract Documents.
- B. Retain at Contractor's office and at the Site complete copy of each Contract modification document and related documents, and Engineer's response.

1.03 REQUEST FOR INTERPRETATION

A. General:

1. Submit written or electronic requests for interpretation to Engineer. Contractor and Owner may submit requests for interpretation.
2. Submit request for interpretation to obtain clarification or interpretation of the Contract Documents. Report conflicts, errors, ambiguities, and discrepancies in the Contract Documents using requests for interpretation.
3. Do not submit request for interpretation when other form of communication is appropriate, such as submittals, requests for substitutions or "or equals", notices,

ordinary correspondence, or other form of communication. Improperly prepared or inappropriate requests for interpretation will be returned without response or action.

B. Procedure:

1. Submit one original (hard copy or electronic) of each request for interpretation. Submit each request for interpretation with separate letter of transmittal if hard copies are submitted.
2. Engineer will provide timely review of requests for interpretation. Allow sufficient time for review and response.
3. Engineer will maintain log of requests for interpretation. Copy of log will be provided upon request.
4. Engineer will provide written response to each request for interpretation. One copy of Engineer's response will be distributed to:
 - a. Contractor
 - b. Owner
 - c. Engineer
 - d. Owner's Site Representative (OSR)

C. If Engineer requests additional information to make an interpretation, provide information requested within ten (10) days, unless Engineer allows additional time, via correspondence referring to request for interpretation number.

D. If Contractor or Owner believes that a change in the Contract Price or Contract Times or other change to the Contract is required, notify Engineer in writing before proceeding with the Work associated with the request for interpretation..

E. Submit each request for interpretation on a form acceptable to Engineer.

1. Number each request for interpretation as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number.
2. In space provided on form, describe the interpretation requested. Provide additional sheets as necessary. Include text and sketches as required in sufficient detail for engineer's response.
3. When applicable, request for interpretation shall include Contractor's recommended resolution.

1.04 FIELD ORDERS

A. General:

1. Field Orders, when required, will be initiated and issued by Engineer.
2. Field Orders authorize minor variations in the Work but do not change the Contract Price or Contract Times.
3. Field Orders will be in the form of Engineers Joint Contract Documents Committee (EJCDC) document C-942, "Field Order" or other Engineer's accepted form.
4. Engineer will maintain a log of Field Orders issued.

B. Procedure.

1. Electronic copies of Field Orders will be maintained, stored, and distributed by electronic construction document management system.
2. If Contractor or Owner believes that a change in the Contract Price or the Contract Times or other change to the Contract is required, immediately notify Engineer in writing before proceeding with the Work associated with the Field Order.
3. If the Field Order is unclear, submit request for interpretation.

1.05 WORK CHANGE DIRECTIVE

A. General:

1. Work Change Directives, when required, order additions, deletions, or revisions to the Work.
2. Work Change Directives do not change the Contract Price or Contract Times but are evidence that the parties to the Contract expect that the change ordered or documented by the Work Change Directive will be incorporated in subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.
3. Work Change Directives will be in the form of EJCDC document C-940, "Work Change Directive" or other Engineer's accepted form.

B. Procedure:

1. Three originals of Work Change Directive signed by Owner and Engineer will be furnished to Contractor, who shall promptly sign each original Work Change Directive and, within five days of receipt, return all originals to Engineer.

2. Original, signed Work Change Directives will be distributed as follows:
 - a. Contractor: One original
 - b. Owner: One original
 - c. Engineer: One original
3. One hard copy of each Work Change Directive will be distributed to: Resident Owner's Site Representative (OSR).
4. When required by Engineer, document for the Work performed under each separate Work Change Directive, for each day, the number and type of workers employed and hours worked; equipment used including manufacturer, model, and year of equipment, and number of hours; materials used, receipts for and descriptions of materials and equipment incorporated into the Work, invoices and labor and equipment breakdowns for Subcontractors and Suppliers, and other information required by Owner or Engineer, in a format acceptable to Engineer. Submit this documentation to Engineer as a Change Proposal.

1.06 PROPOSAL REQUESTS

A. General:

1. Proposal requests may be initiated by Engineer or Owner.
2. Proposal requests are for requesting the effect on the Contract Price and the Contract Times and other information relative to contemplated changes in the Work. Proposal requests do not authorize changes or variations in the Work, and do not change the Contract Price or Contract Times or terms of the Contract.
3. Proposal requests will be furnished using the proposal request form included with this Section.

B. Procedure.

1. One copy of each signed proposal request will be furnished to Contractor with one copy each to:
 - a. Owner
 - b. Engineer
 - c. Owner's Site Representative (OSR)
2. Submit request for interpretation to clarify conflicts, errors, ambiguities, and discrepancies in proposal request.

3. Upon receipt of proposal request, Contractor shall prepare and submit a Change Proposal, in accordance with this Section, for the proposed Work described in the proposal request.

1.07 CHANGE PROPOSALS

A. General.

1. Submit written Change Proposal to Engineer in response to each proposal request, and when Contractor believes a change in the Contract Price or Contract Times or other change to the terms of the Contract is required.

B. Procedure.

1. Submit to Engineer one original and one copy of each Change Proposal with accompanying documentation, and simultaneously submit two copies to Owner. Submit each Change Proposal with separate letter of transmittal.
2. Engineer will review Change Proposal and either request additional information from Contractor or provide to Owner recommendation regarding approval of the Change Proposal.
3. When Engineer requests additional information to render a decision, submit required information within five days of receipt of Engineer's request, unless Engineer allows more time. Submit the required information via correspondence that refers to Change Proposal number.
4. Upon completing review, one copy of Engineer's written response, if any, will be distributed to:
 - a. Contractor
 - b. Owner
 - c. Engineer
 - d. Owner's Site Representative (OSR)
5. If Change Proposal is recommended for approval by Engineer and approved by Owner, a Change Order will be issued.
6. If parties do not agree on terms for the change, Owner or Contractor may file a Claim against the other, in accordance with the General Conditions and the Supplementary Conditions.

- ### **C. Each Change Proposal shall be submitted on a Change Proposal form acceptable to Engineer.**

1. Number each Change Proposal as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First Change Proposal for the general contract for project named "Contract 23" would be, "Proposal No. 23-001".
2. In space provided on form:
 - a. Describe scope of each proposed change. Include text and sketches on additional sheets as required to provide detail sufficient for Engineer's review and response. If a change item is submitted in response to proposal request, write in as scope, "In accordance with Change Proposal Request No." followed by the proposal request number. Provide written clarifications, if any, to scope of change.
 - b. Provide justification for each proposed change. If change is in response to proposal request, write in as justification, "In accordance with Change Proposal Request No." followed by the proposal request number.
 - c. List the total change in the Contract Price and Contract Times for each proposed change.
3. Unless otherwise directed by Engineer, attach to the Change Proposal detailed breakdowns of pricing (Cost of the Work and Contractor's fee) including:
 - a. List of Work tasks to accomplish the change.
 - b. For each task, labor cost breakdown including labor classification, total hours per labor classification, and hourly cost rate for each labor classification.
 - c. Construction equipment and machinery to be used, including manufacturer, model, and year of manufacture, and number of hours for each.
 - d. Detailed breakdown of materials and equipment to be incorporated into the Work, including quantities, unit costs, and total cost, with Supplier's written quotations.
 - e. Breakdowns of the Cost of the Work and fee for Subcontractors, including labor, construction equipment and machinery, and materials and equipment incorporated into the Work, other costs, and Subcontractor fees.
 - f. Breakdown of other costs eligible, in accordance with the General Conditions and the Supplementary Conditions.
 - g. Other information required by Engineer.

- h. Contractor's fees applied to eligible Contractor costs and eligible Subcontractor costs.

1.08 CHANGE ORDERS

A. General:

1. Change Orders will be recommended by Engineer and signed by Owner, and Contractor, to authorize additions, deletions, or revisions to the Work, or changes to the Contract Price or Contract Times.
2. Change Orders will be in the form of EJCDC document C-941, "Change Order" or other Engineer's accepted form.

B. Procedure.

1. Five originals of each Change Order will be furnished to Contractor, who shall sign each original Change Order and return all originals to Engineer within five days of receipt.
2. Engineer will sign each original Change Order and forward them to Owner.
3. After approval and signature of all parties, three executed original copies will be returned to Engineer. Engineer will distribute as follows:
 - a. Contractor: One original
 - b. Owner: One original
 - c. Engineer: One original
4. One copy of each Change Order will be distributed to:
 - a. Owner's Site Representative (OSR)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SCHEDULE

- A. 2018 EJCDC Form C-942, Field Order
- B. 2018 EJCDC Form C-940, Work Change Directive

C. 2018 EJCDC Form C-941, Change Order

END OF SECTION

Field Order No. _____

Date of Issuance: _____ Effective Date: _____
Owner: _____ Owner's Contract No.: _____
Contractor: _____ Contractor's Project No.: _____
Engineer: _____ Engineer's Project No.: _____
Project: _____ Contract Name: _____

Contractor is hereby directed to promptly execute this Field Order, issued in accordance with General Conditions Paragraph 9.04, for minor changes in the Work without changes in Contract Price or Contract Times. If Contractor considers that a change in Contract Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference: _____
Specification(s) Drawing(s) / Detail(s)

Description:

Attachments:

ISSUED: RECEIVED:
By: _____ By: _____
Engineer (Authorized Signature) Contractor (Authorized Signature)
Title: _____ Title: _____
Date: _____ Date: _____

Copy to: Owner

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CONTACT BASIN DESIGN

01 26 00-9 GREEN CANYON WTP DISINFECTION

Date of Issuance:	Effective Date:
Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

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

Description:

Attachments: [List documents supporting change]

Purpose for Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to changes on Contract Price and Contract Time, is issued due to: [check one or both of the following]

- Non-agreement on pricing of proposed change.
- Necessity to proceed for schedule or other Project reasons.

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

Contract Price	\$ _____	[increase] [decrease].
Contract Time	____ days	[increase] [decrease].

Basis of estimated change in Contract Price:

- Lump Sum
- Unit Price
- Cost of the Work
- Other

RECOMMENDED:

AUTHORIZED BY:

RECEIVED:

By: _____	By: _____	By: _____
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable)

By: _____

Date: _____

Title: _____

Date of Issuance:	Effective Date:
Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

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

Description:

Attachments: [List documents supporting change]

<p>CHANGE IN CONTRACT PRICE</p> <p>Original Contract Price:</p> <p>\$</p>	<p>CHANGE IN CONTRACT TIMES [note changes in Milestones if applicable]</p> <p>Original Contract Times: Substantial Completion: Ready for Final Payment: days or dates</p>
<p>[Increase] [Decrease] from previously approved Change Orders No. to No. :</p> <p>\$</p>	<p>[Increase] [Decrease] from previously approved Change Orders No. to No. : Substantial Completion: Ready for Final Payment: days</p>
<p>Contract Price prior to this Change Order:</p> <p>\$</p>	<p>Contract Times prior to this Change Order: Substantial Completion: Ready for Final Payment: days or dates</p>
<p>[Increase] [Decrease] of this Change Order:</p> <p>\$</p>	<p>[Increase] [Decrease] of this Change Order: Substantial Completion: Ready for Final Payment: days or dates</p>
<p>Contract Price incorporating this Change Order:</p> <p>\$</p>	<p>Contract Times with all approved Change Orders: Substantial Completion: Ready for Final Payment: days or dates</p>

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____ Engineer (if required)	By: _____ Owner (Authorized Signature)	By: _____ Contractor (Authorized Signature)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Approved Funding Agency (if required)

By: _____

Date: _____

Title: _____

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SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for preliminary and final Schedule of Values.
2. Schedule of Values and the Progress Schedule updates specified in Section 01 32 00 – Construction Progress Schedule, shall be basis for preparing each Application for Payment. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.

1.02 ADMINISTRATIVE REQUIREMENTS

A. General Requirements:

1. Schedule of Values shall include breakdown of costs for materials and equipment, installation, and other costs used in preparing the Bid by Contractor and each Subcontractor. List purchase and delivery costs for materials and equipment for which Contractor may apply for payment as stored materials.
2. Include separate amounts for each Specification Section in the Contract Documents by structure, building, and work area.
3. Identify each line item with number corresponding to the associated Specification Section number. List sub-items of major products or systems, as appropriate or when requested by Engineer.
4. Include in Schedule of Values unit price payment items with their associated quantity. Provide in the Schedule of Values detailed breakdown of unit prices when required by Engineer.
5. Include in Schedule of Values itemized list of Work for each major part of the Contract, for each payment item specified in Section 01 20 00 – Measurement and Payment.
6. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.

B. Specific Requirements:

1. Include in each line item a directly proportional amount of Contractor's overhead and profit. Do not include overhead and profit as separate item(s).
 2. Include separate line item for each allowance, and for each unit price item
 3. Include line item for bonds and insurance in amount not exceeding two percent of the Contract Price. This may be applied for in the first Application for Payment.
 4. Include items for the General Conditions, permits (when applicable), construction Progress Schedule, and other items required by Engineer. Include such items in Applications for Payment on schedule accepted by Engineer
 5. Line items for Site maintenance such as dust control, snow removal, compliance with storm water pollution prevention plans and permits, spill prevention control and countermeasures plans, and for construction photographic documentation; temporary utilities and temporary facilities, field offices, temporary controls, field engineering, and similar Work shall be included in the Schedule of Values and proportioned in Applications for Payment throughout duration of the Work.
 6. Include separate line items under each appropriate payment item for mobilization and demobilization. Document for Engineer the activities included in mobilization and demobilization line items.
 - a. Mobilization will be limited to two percent of the Contract Price, and will be paid in two payments, each of 50 percent of total amount for mobilization.
 - b. Demobilization shall be at least one percent of the Contract Price and shall be included with the Application for Payment following Substantial Completion, or other schedule accepted by Engineer.
 7. Costs for submittals, operations and maintenance manuals, field testing, and training of operations and maintenance personnel shall be as follows, unless otherwise accepted by Engineer:
 - a. Up to 3.0 percent of total cost (including overhead and profit) for the equipment and material may be apportioned to submittal preparation and finalization and final submittal of operations and maintenance manuals and included in the Application of Payment following Engineer providing acceptable submittal review disposition.
- C. Preliminary Schedule of Values: Submit preliminary Schedule of Values to Engineer for initial review. Contractor shall incorporate Engineer's comments into the Schedule of Values and resubmit to Engineer. Engineer may require corrections and re-submittals until Schedule of Values is acceptable.
- D. Time Frame for Submittals:

1. Submit preliminary Schedule of Values within ten days of date that the Contract Times commence running in accordance with the Notice to Proceed.
2. Submittal of the Schedule of Values shall be in accordance with the General Conditions. Engineer will not accept Applications for Payment without an acceptable Schedule of Values.
3. When required by Engineer, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price.

1.03 SUBMITTALS

A. Submit the following:

1. Electronic copies of preliminary Schedule of Values.
2. Electronic copies of Schedule of Values.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 29 76
PROGRESS PAYMENT PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

- A. Administrative and procedural requirements for progress payment to the Contractor by the Owner.
- B. Related Sections:
 - 1. Section 01 77 19 – Closeout Requirements.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. General: Contractor's request for payment shall be in accordance with the Agreement, General Conditions and Supplementary Conditions, and the Specifications.
- B. Procedure:
 - 1. Review with Owner's Site Representative (OSR) quantities and the Work proposed for inclusion in each progress payment. Application for Payment shall cover only the Work and quantities recommended by the OSR.
 - 2. Submit to Engineer electronic originals of each complete Application for Payment and other documents to accompany the Application for Payment.
 - 3. Engineer will act on request for payment in accordance with the General Conditions and Supplementary Conditions.
- C. Requirements:
 - 1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have the same level of detail as the Schedule of Values.
 - 2. For materials and equipment not incorporated in the Work but suitably stored, submit documentation in accordance with the General Conditions and Supplementary Conditions. Legibly indicate on invoice or bill of sale the specific materials or equipment included in the payment request and corresponding bid/payment item number for each.
 - 3. Contractor's Affidavit is required for payment application and requests beginning with the second application for payment.

4. For payment requests that include payment for Work under an allowance, submit documentation acceptable to Owner of the authorization of allowance Work.
 5. For payment requests (other than request for final payment) that include reduction or payment of retainage in an amount greater than that required in the Contract Documents, submit on form acceptable to Owner consent of surety to partial release or reduction of retainage.
- D. Requirements for request for final payment are in the General Conditions, as modified by the Supplementary Conditions, and Section 01 77 19 – Closeout Requirements.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pre-Construction Meeting:

- a. Purpose of conference is to designate responsible personnel, establish working relationships, discuss preliminary schedules submitted by Contractor, and review administrative and procedural requirements for the Project. Matters requiring coordination will be discussed and procedures for handling such matters will be established.
- b. Date, Time and Location: Conference will be held after execution of the Contract and before Work starts at the Site. Engineer will establish the date, time, and location of conference and notify the interested and involved parties.

2. Progress Meetings:

- a. Progress meetings will be held throughout the Project. Contractor shall attend each progress meeting prepared to discuss in detail all items on the agenda.
- b. Engineer will preside at progress meetings and will prepare and distribute minutes of progress meetings to all meeting participants and others as requested.
- c. Date, Time and Location:
 - 1) Regular Meetings: Every month on a day and time agreeable to Owner, Engineer, and Contractor.
 - 2) Engineer's Field Office at the Site or other location mutually agreed upon by Owner, Contractor, and Engineer.
- d. Additional meetings may be conducted as progress of Work requires at a mutually agreed date, time and location.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Pre-Construction Meeting:

1. Contractor shall provide pre-construction meeting submittals with sufficient number of copies for each attendee:
2. Required Attendees:
 - a. Contractor
 - 1) Project manager.
 - 2) Site superintendent.
 - 3) Safety representative.
 - 4) Major Subcontractors.
 - a) Electrical
 - b) Concrete
 - c) Excavation
 - b. Owner.
 - c. Engineer.
 - d.
 - e. Owner's Site Representative (OSR).
 - f. Representatives of governmental or other regulatory agencies.
3. Contractor shall prepare and submit a health and safety plan, including confined space entry plan, as specified in this Section prior to the pre-construction meeting.
4. Agenda, minimum:
 - a. Procedural requirements:
 - 1) Designation of responsible personnel
 - 2) Use of Site and Owner's requirements, including general regards for community relations
 - 3) Delivery of materials and equipment to the Site
 - 4) Safety and first aid procedures
 - 5) Confined space entry plan
 - 6) Security procedures

- 7) Housekeeping procedures
- b. Administrative requirements:
- 1) Distribution of Contract Documents.
 - 2) Shop Drawing submittal procedures.
 - 3) Maintaining record documents at the Site.
 - 4) Contract modification procedures
 - 5) Processing of Payment Application
- c. Site mobilization requirements:
- 1) Working hours, overtime, and holidays.
 - 2) Field offices, trailers, and staging areas.
 - 3) Temporary facilities and utilities, including usage and coordination.
 - 4) Temporary controls, such as sediment and erosion control, noise, dust, storm water, and other measures.
 - 5) Access to Site, access roads, and parking for construction vehicles.
 - 6) Protection of traffic and existing property, including site barriers and temporary fencing.
 - 7) Security
 - 8) Storage of materials and equipment.
 - 9) Reference points and benchmarks, surveys and layouts.
 - 10) Site maintenance during the project, including cleaning and removal of trash and debris.
 - 11) Site restoration.
- d. Schedules
- 1) Preliminary construction schedule
 - 2) Critical work sequencing
 - 3) Preliminary Shop Drawing submittal schedule
 - 4) Preliminary Schedule of Values

B.

Progress Meetings:

1. Progress meetings frequency shall be conducted as specified in this Section, unless modified and agreed upon by Owner, Contractor, and Engineer. Additional meetings may be conducted as progress of Work requires.
2. Contractor shall provide submittals specified in this Section prior to each progress meeting.
3. Attendance:
 - a. Contractor, including project manager, site superintendent, safety representative, and representatives of Subcontractors and Suppliers as required.
 - b. Engineer, including project manager (or designated representative), Resident Project Representative (if any), others as required by Engineer.
 - c. Owner, including Owner's Site Representative (if any).
 - d. Subcontractors, only with Engineer's approval or request, as required in the agenda.
4. Agenda, minimum:
 - a. Review, comment, and amendment (if required) of minutes of previous progress meeting.
 - b. Review of progress since the previous progress meeting.
 - c. Planned progress through next 30 – 60 days.
 - d. Review of Progress Schedule
 - 1) Contract Times, including Milestones (if any)
 - 2) Critical path.
 - 3) Schedules for fabrication and delivery of materials and equipment.
 - 4) Corrective measures, if required.
 - e. Submittals:
 - 1) Review of status of critical submittals.
 - 2) Review revisions to schedule of submittals.

- f. Contract Modifications:
 - 1) Requests for interpretation
 - 2) Clarification notices
 - 3) Field Orders
 - 4) Proposal requests
 - 5) Change Proposals
 - 6) Work Change Directives.
 - 7) Change Orders.
 - 8) Claims.
- g. Applications for progress payments.
- h. Problems, conflicts, and observations.
- i. Quality standards, testing, and inspections.
- j. Coordination between parties.
- k. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.
- l. Safety.
- m. Permits.
- n. Record documents status.
- o. Punch list status, as applicable.
- p. Other business.

1.03 SUBMITTALS

A. Pre-Construction Meeting Submittals:

- 1. Prior to the conference, submit the following preliminary schedules in accordance with the General Conditions:
 - 1) Progress schedule
 - 2) Schedule of submittals

3) Schedule of values

2. Contractor's safety and first aid procedures.
3. Confined space entry plan.
4. List of emergency contact information

B. Progress Meeting Submittals:

1. List of Work accomplished since the previous progress meeting.
2. Up-to-date Progress Schedule.
3. Up-to-date Schedule of Submittals.
4. Detailed "look-ahead" schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the Owner, Project, and Site.
5. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

1.04 EMERGENCY CONTACT INFORMATION

- A. Contractor shall provide list of emergency contact information for 24-hour use throughout the Project. Emergency contact information shall be updated and kept current throughout the Project. If personnel or contact information change, provide updated emergency contact information list at the next progress meeting.
- B. Contractor's list of emergency contact information shall include:
1. Contractor's project manager's office, field office, cellular, and home telephone numbers.
 2. Contractor's Site superintendent's office, field office, cellular, and home telephone numbers.
 3. Contractor's foreman's field office, cellular (if available), and home telephone numbers.
 4. Major Subcontractors' and Suppliers' office, cellular, and home telephone numbers of project manager and foreman (when applicable).
- C. Additional Emergency Contact Information:
1. Owner's Project Manager: office, cellular, and home telephone numbers.

2. Owner's central 24-hour emergency telephone number.
3. Engineer's project engineer's office, cellular, and home telephone numbers.
4. Owner's Site Representative's office, field office, cellular, and home telephone numbers.
5. Emergency telephone numbers, including: "Emergency: Dial 911", and seven-digit telephone numbers for the hospital, ambulance, police, and fire department nearest to the Site. Provide names of each of these institutions.
6. Other involved entities as applicable.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 00
CONSTRUCTION PROGRESS SCHEDULE

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes: Detailed requirements and/or procedures for, including but not limited to, the Preliminary Project Schedule, Project Schedule Updates, Project Schedule development, Time Impact Analysis, and Recovery Schedules
- B. The Contractor shall develop, revise, and provide all information and input required for the Project Schedule for the performance of the Work in accordance with the requirements of the Contract Documents in general and, in particular, this section. The Progress Schedule shall incorporate the requirements of General Conditions, Supplementary Conditions, and all items specified in this section.
- C. Except as otherwise provided herein or elsewhere in the Contract Documents, the planning, scheduling, coordination, and execution of the Work is the sole responsibility of the Contractor.

1.02 REFERENCES

- A. Definitions:
 - 1. Activity: An element of the construction work that has the following specific characteristics: consumes time, consumes resources, has a definable start and finish, is assignable, and is measurable.
 - 2. Constraint: An imposed date on the Progress Schedule or an imposed tie between Activities. The Contract Times are Constraints.
 - 3. CPM Progress Schedule: Computerized Progress Schedule in Critical Path Method (CPM) format which accounts for the entire Work, defines the interrelationships between elements of the Work, reflects the uncompleted Work, and indicates the sequence with which the Work has been completed, indicates the sequence in which uncompleted Work will be completed, and indicates the duration of each Activity.
 - 4. Critical Path: The continuous chain of Activities with the longest duration for completion within the Contract Times.
 - 5. Early Start: The earliest possible date an Activity can start according to the assigned relationships among Activities.

6. Early Finish: The earliest possible date an Activity can finish according to the assigned relationships among the Activities.
7. Late Finish: The latest possible date an Activity can finish without extending the Contract Times.
8. Late Start: The latest possible date an Activity can start without extending the Contract Times.
9. Total Float: The total number of days that an Activity (or chain of Activities) can be delayed without affecting the Contract Times. Total float for each Activity shall be calculated as the difference between Early Finish and Late Finish.
10. Network Diagram: A time-scaled logic diagram depicting the durations and relationships of the Activities.
11. Work Areas, Area, or System: A logical breakdown of the Project elements or a group of Activities which, when collectively assembled, are readily identifiable on the Project (for example, yard piping, a structure or building, a treatment process, or other logical grouping).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Initial Progress Schedule:

1. Type and Organization of Progress Schedules:
 - a. Prepare one Progress Schedule covering the entire Project using Primavera Planner (P6 or newer), or Microsoft Project scheduling software.
 - b. Schedule submittals shall include the electronic native file format (i.e., scheduling software file), and a PDF file of the schedule's logic diagram.
 - c. Time Scale: Indicate first date of each work week.
 - d. Activity Designations: Indicate concise description of the Work represented by the activity and related Specification Section number. The Work related to each activity shall be limited to one work trade and one construction area.
2. Submitted PDF files shall be in a Gantt Chart Format and shall show the following:
 - a. Activity identification number.
 - b. Activity description.

- c. Activity duration (in workdays).
 - d. Activity percent complete
 - e. Start, Early Start, Late Start, Finish, Early Finish, and Late Finish Dates
 - f. Total Float for each Activity.
 - g. Critical Path denoted.
3. Organization:
- a. Group shop drawings, samples and other submittals into a separate sub-schedule that is part of the Progress Schedule.
 - b. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
 - c. Group construction into Work Area sub-schedules (that are part of the Progress Schedule) by Activity.
 - d. Clearly indicate the Critical Path on the Progress Schedule.
 - e. Organize each Work Area sub-schedule by Specification Section number.
4. Preliminary Progress Schedule:
- a. Contractor shall submit to Engineer the Preliminary Progress Schedule within ten (10) days after the Contract Times commence running.
5. Initial Acceptance of Progress Schedule:
- a. At least 10 days before submission of the first Application for Payment, Contractor shall schedule a conference at the Site for review of the Preliminary Progress Schedule.
 - 1) Attendees shall include Contractor, Engineer, Owner, and others as required.
 - 2) Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the Progress Schedule.
 - 3) Owner reserves the right to not make progress payment to Contractor until acceptable Progress Schedule, and other

reports and schedule-related documents required are submitted to Engineer.

- b. Initially-accepted Progress Schedule shall be identified as the Baseline Progress Schedule. The Baseline Progress Schedule shall not be revised without Owner and Engineer approval.

B. Project Schedule Updates:

1. Project Schedule Updates shall be prepared on a monthly basis throughout the entire Contract Time and until Project Final Completion. The Engineer will not recommend progress payments by the Owner until a complete Project Schedule Update (including Schedule Narrative Report) is received, reviewed, and accepted by the Engineer.
2. The update to the Progress Schedule shall be based on retained logic. Progress override logic is not allowed.
3. Required scheduling software, and schedule organization, format, and content for updated Progress Schedules are identical to that required in this Section for initial Progress Schedules.
4. For all Project Schedule Updates, the percent complete reported for individual Activities shall be based on Work accepted and paid for by the Owner in monthly pay applications. Failure to comply with this requirement shall result in rejection of the submitted update. Rejection of the Project Schedule Update will in turn result in the Engineer not recommending progress payments by the Owner.
5. Monthly Progress Schedule Updates shall be accompanied by a Schedule Narrative Report. The report shall:
 - a. Describe Work completed within the preceding month.
 - b. Describe Work planned for the following month (including a look-ahead schedule).
 - c. Identify proposed changes or revisions to the Baseline Progress Schedule.
 - d. Identify all Work performed out of sequence.
 - e. Identify problem areas.
 - f. Identify current or anticipated conditions which may delay the Work.

1.04 PROJECT SCHEDULE DEVELOPMENT

- A. The schedule shall cover the entire Contact Time, and the Work shall be scheduled to complete the Project within the Contract Time.
- B. The Schedule's Late Finish Date shall equal the Contract Completion Date.
- C. All activities except for the NTP and Final Completion shall have a predecessor and a successor. No open-ended activities will be permitted. Note that NTP shall have a successor, or successors and Final Completion shall have a predecessor or predecessors.
- D. Proposed durations assigned to each activity shall be the Contractor's best estimate of time required to complete the activity, considering the scope and resources planned for the activity.
- E. The durations of activities shall be expressed in whole working days, with a maximum duration of 20 workdays each, unless otherwise approved or directed by the Engineer or the Owner. The duration of non-construction activities including mobilization, shop drawings and sample submittals, fabrication of materials and equipment, and delivery of materials and equipment may exceed this limitation.
- F. The Schedule shall incorporate in detail all elements of the Work contained within the Contract Documents. Specific elements of the Work to incorporate into the schedule include but are not limited to the following:
 - 1. Notice to Proceed.
 - 2. Mobilization and demobilization.
 - 3. Submittals including O&M Manuals. Note that durations for Engineer review time shall be 30 working days unless specified elsewhere in these Contract Documents.
 - 4. Fabrication and procurement activities.
 - 5. Temporary construction activities and relocations
 - 6. Permitting
 - 7. Erosion control
 - 8. Site clearing
 - 9. Site restoration
 - 10. All requirements for coordination with Owner operations
 - 11. Concrete curing and form removal

12. All testing activities
13. Inspections as required by local authorities.
14. Interim Milestones as defined by this Contact or as deemed critical as the project progresses.
15. All requirements related to facility startup and commissioning.
16. Substantial Completion (including the period for performing the punchlist)
17. Final Completion

1.05 TIME IMPACT ANALYSIS

A. General:

1. Prepare and submit a time impact analysis when one or more of the following occurs:
 - a. Change Order proposal is prepared.
 - b. Work Change Directive is issued that will affect the Progress Schedule.
 - c. When delays are experienced.
2. Time impact analysis shall illustrate the influence of each Change Order, Work Change Directive, or delay.
3. Each time impact analysis shall include a sketch (fragnet) demonstrating how Contractor proposes to incorporate the changes in the Project or, as applicable, delays into the Progress Schedule. Fragnet shall include all logic, and additions required as result of said Change Order, Work Change Directive, or delay.
4. Fragnet shall show all CPM logic revisions for the Work associated with the Change Order, Work Change Directive, or delay and its relationship to other Activities.
5. Timing of Time Impact Analysis:
 - a. Submit each time impact analysis within 7 days after the following, as applicable:
 - 1) Start of the delay.
 - 2) After the submittal of Change Order proposal to Engineer

3) After Contractor's Receipt of Work Change Directive.

- b. Failure to Submit Time Impact Analysis: When General Contractor does not submit time impact analysis for a specific change or delay under the General Contract, within the specified period of time for such submittal, such non-submittal shall be construed that no extension of the Contract Times is required

B. Evaluation by Engineer and Acceptance:

1. Engineer's evaluation of each time impact analysis comprised of complete information will be completed in timely manner after Engineer's receipt. Changes in the Contract Times will be made only by Change Order.
2. When mutual agreement is reached between the parties, on effect of the change or delay in the Project, incorporate into the next Progress Schedule and update the associated fragnets illustrating the influence of changes and delays.

1.06 RECOVERY SCHEDULES

A. General:

1. When updated Progress Schedule indicates that the ability to comply with the Contract Times falls 30 or more days behind schedule, and there is no excusable delay, Change Order, or Work Change Directive to support an extension of the Contract Times, Contractor shall prepare and submit a Progress Schedule demonstrating Contractor's plan to accelerate the Project to achieve compliance with the Contract Times (i.e., "recovery schedule") for Engineer's acceptance.
2. Submit recovery schedule within 14 days after submittal of updated Progress Schedule where need for recovery schedule is indicated.

B. Implementation of Recovery Schedule:

1. At no additional cost to Owner, Contractor shall do one or more of the following:
 - a. Furnish additional labor and construction equipment.
 - b. Employ additional work shifts.
 - c. Expedite procurement of materials and equipment to be incorporated into the Work.
 - d. Other measures necessary to complete the Work within the Contract Times.

2. Upon acceptance of recovery schedule by Engineer, incorporate recovery schedule into the next Progress Schedule update.
- C. Lack of Action: Contractor's refusal, failure or neglect to submit a recovery schedule, shall constitute reasonable evidence that Contractor is not prosecuting the Work or separable part thereof with the diligence that will ensure completion within the Contract Times. Such lack of action shall constitute sufficient basis for Owner to exercise remedies available to Owner under the Contract Documents

1.07 USE OF FLOAT

- A. Total Float and Contract Float belong to the Project and may be used by Owner, Engineer, or Contractor to accommodate modifications, regardless of origination, in the Work or to mitigate the effect of events that may delay performance or completion of the Work.
- B. Changes or delays that influence scheduled Work Activities with Float and that do not extend the critical path will not be justification for an extension in Contract Times.

1.08 SUBMITTALS

- A. Action/Informational Submittals:
 1. Initial Progress Schedules:
 - a. Preliminary Progress Schedule
 - b. Acceptable Progress Schedule (Baseline)
 2. Progress Schedule Updates:
 - a. Progress Schedule updates shall comply with requirements of this Section and shall include updated Progress Schedule and Schedule Narrative Report.
 - b. Submit updated Progress Schedule at each progress meeting. If a Progress Schedule remains unchanged from one progress meeting to the next, submit a written statement to that effect.
 3. Time Impact Analyses: Submit in accordance with this Section.
 4. Recovery Schedule: Submit in accordance with this Section.
 5. Qualifications: Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and maintaining the Progress Schedule.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes:

1. Contractor shall provide submittals in accordance with the General Conditions as modified by the Supplementary Conditions, and this Section.
2. Contractor is responsible to confirm and correct dimensions at the Site, for information pertaining to the fabrication processes and to techniques of construction, and for coordinating the work of all trades. Contractor's signature of submittal's stamp and letter of transmittal shall be Contractor's representation that Contractor has met their obligations under the Contract Documents relative to that submittal.

B. Related Sections:

1. Section 01 25 00 – Substitution Procedures.
2. Section 01 78 23 – Operation and Maintenance Data.
3. Section 01 78 39 – Project Record Documents.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Types of Submittals: When type of submittal is not specified and is not specified in this Section, Engineer will determine type of submittal.

1. Action/Informational Submittals:

- a. Shop Drawings.
- b. Product data.
- c. Delegated design submittals in accordance with the General Conditions and as modified by the Supplemental Conditions.
- d. Samples.
- e. Testing plans, procedures, and testing limitations.

- f. Design data not sealed and signed by a design professional retained by Contractor, Subcontractor, or Supplier.
 - g. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, potentially Hazardous Environmental Conditions, and similar reports.
 - h. Supplier instructions, including installation data, and instructions for handling, starting-up, and troubleshooting.
 - i. Sustainable design submittals (other than sustainable design closeout documentation).
 - j. Lesson plans for training and instruction of Owner's personnel.
2. Closeout Submittals:
- a. Maintenance contracts.
 - b. Operations and maintenance data.
 - c. Bonds, such as maintenance bonds and bonds for a specific product or system.
 - d. Warranty documentation.
 - e. Record documentation.
 - f. Sustainable design closeout documentation.
 - g. Software.
3. Maintenance Material Submittals:
- a. Maintenance materials schedule and checklist.
 - b. Spare parts.
 - c. Extra stock materials.
 - d. Tools.
4. Quality Assurance Submittals:
- a. Performance affidavits.
 - b. Certificates.

- c. Source quality control submittals (other than testing plans, procedures, and testing limitations), including results of shop testing.
- d. Field or Site quality control submittals (other than testing plans, procedures, and testing limitations), including results of operating and acceptability tests at the Site.
- e. Supplier reports.
- f. Special procedure submittals, including health and safety plans and other procedural submittals.
- g. Qualifications statements.

B. Submittal Requirements:

- 1. Contractor shall submit electronic copy of submittals for Engineer's review via Procore Document Management Construction Management Information System (CMIS), unless otherwise specified in individual Specification Sections. Acceptable electronic formats are Adobe PDF, Microsoft Word, Autodesk DWF and AutoCAD.
- 2. Submittal shall be accompanied by letter of transmittal containing date, project title, Contractor's name, number and title of submittal, list of relevant Specification Sections, notification of deviations from Contract Documents, and other material required for Engineer's review.
- 3. Submittals with internet hyperlinks and other references to online content shall not be considered, reviewed, and included as part of the submittal review procedure. Hyperlinks and other electronic references shall not be used to comply with specified requirements of the Contract Documents, unless specifically stated in the individual technical Specification Section.

C. Scheduling:

- 1. Provide submittals well in advance of the Work following Engineer's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents.
- 2. Submittals shall be provided by Contractor with at least thirty (30) working days for review and processing.

1.03 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals, as specified in this Section:

1. Timing:
 - a. Provide submittal within time frames specified in the Contract Documents.
 - b. Provide updated Schedule of Submittals with each submittal of the updated Progress Schedule.

2. Content: In accordance with the General Conditions as modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent submittals of the Schedule of Submittals are identical.
 - a. Identify submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path.
 - b. Indicate the following for each submittal:
 - 1) Date when submittals are requested and received from Supplier.
 - 2) Date when certification is received from Supplier and when submitted to Engineer.
 - 3) Date when submittals are submitted to Engineer and returned with disposition from Engineer.
 - 4) Date when submittals are revised by Supplier and submitted to Engineer.
 - 5) Date when submittals are returned with "Furnish as Submitted" (FAS) or "Furnish as Corrected" (FAC) disposition from Engineer.
 - 6) Date when approved submittals are returned to Supplier.
 - 7) Date of Supplier scheduled delivery of equipment and material.
 - 8) Date of actual delivery of equipment and material.
 - 9) Whether submittal will be for a substitution or "equal". Procedures for substitutions and "or equals" are specified in the General Conditions and the Section 01 25 00 – Substitution Procedures.
 - 10) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors.

3. Prepare Schedule of Submittals using same software, and in same format, specified for Progress Schedules.
4. Coordinate Schedule of Submittals with the Progress Schedule.
5. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate submittals on the Project's critical path, or that places extraordinary demands on Engineer for time and resources, is unacceptable. Do not include submittals not required by the Contract Documents.
6. In preparing Schedule of Submittals:
 - a. Considering the nature and complexity of each submittal, allow sufficient time for review and revision.
 - b. Reasonable time shall be allowed for: Engineer's review and processing of submittals, for submittals to be revised and resubmitted, and for returning submittals to Contractor.
 - c. Identify and accordingly schedule submittals that are expected to have long anticipated review times.

1.04 ACTION/INFORMATIONAL SUBMITTALS

- A. Provide the following Submittals in accordance with the individual Specification Sections, including, but not limited to, the following:
 1. Product Data:
 - a. Catalog cut-sheets
 - b. Descriptive bulletins/brochures/specifications
 - c. Material of construction data, including details on all components including applicable ASTM designations.
 - d. Lifting, erection, installation, and adjustment instructions, and recommendations.
 - e. Finish/treatment data, including interior and exterior shop coating systems.
 - f. Equipment/material weight/loading data, including total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations following installation. Size, placement, and embedment requirements of anchor bolts.

- g. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.
 - h. Motor data including horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at $\frac{1}{2}$, $\frac{3}{4}$, and full load; slip at full load; running, full load, and locked rotor current values; safe running time-current curves; motor protective devices; and interconnection diagrams.
 - i. Engineering design data, calculations, and system analyses
 - j. Digital system documentation
 - k. Operating sequence descriptions
 - l. Software/programming documentation
 - m. Manufacturer's instructions
2. Shop Drawings:
- a. Equipment and material layout drawings, including panel layout drawings.
 - b. System schematics and diagrams including, but not limited to, piping systems; HVAC and ventilation systems; process equipment systems; electrical operating systems; wiring diagrams; controls, alarm and communication systems.
 - c. Layout and installation drawings (interior and exterior) for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc.
 - d. Layout and installation drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.
 - e. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.
 - f. Drawings for pipes, ducts, conduits, etc., shall show all 3 inch and larger electrical conduits and pressure piping, electrical cable trays, heating and

ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.

- g. Equipment and material schedules.
- 3. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by Contractor, Subcontractor, or Supplier for materials and equipment to be incorporated into the completed Work. Delegated design submittals do not include submittals related to temporary construction unless specified otherwise in the related Specification Section. Delegated design submittals include: design drawings, design data including calculations, specifications, certifications, and other submittals prepared by such design professional.

B. Samples:

- 1. General Requirements:
 - a. Conform submittal of Samples to the General Conditions as modified by the Supplementary Conditions, this Section, and the Specification Section in which the Sample is specified.
 - b. Furnish at the same time Samples and submittals that are related to the same unit of Work or Specification Section. Engineer will not review submittals without associated Samples and will not review Samples without associated submittals.
 - c. Samples shall clearly illustrate functional characteristics of product, all related parts and attachments, and full range of color, texture, pattern, and material.
- 2. Submittal Requirements:
 - a. Securely label or tag Samples with submittal identification number. Label or tag shall not cover, conceal, or alter appearance or features of Sample. Label or tag shall not be separated from the Sample.
 - b. Submit number of Samples required in Specifications. If number of Samples is not specified in the associated Specification Section, provide at least one identical Samples of each item required for Engineer's approval. If Contractor requires Sample(s) for Contractor's use, notify Engineer in writing and provide additional Sample(s). Contractor is responsible for furnishing, shipping, and transporting additional Samples.

- c. Deliver one Sample to Engineer's field office at the Site. Deliver balance of Samples to location directed by Engineer.

1.05 CLOSEOUT SUBMITTALS

- A. Provide the following Closeout Submittals in accordance with the individual Specification Sections, including, but not limited to, the following:
 - 1. Maintenance contracts
 - 2. Bonds for specific products or systems
 - 3. Warranty documentation
 - 4. Sustainable design closeout documentation.
 - 5. Software programming and documentation.
- B. On documents such as maintenance contracts and bonds, include on each document furnished original signature of entity issuing the document.
- C. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 – Operations and Maintenance Data.
- D. Record Documentation: Submit in accordance with Section 01 78 39 – Project Record Documents.
- E. Disposition: Dispositions and meanings are the same as specified for Informational Submittals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. For spare parts, extra stock materials, and tools, submit quantity of items specified in associated Specification Section.
- B. Disposition: Dispositions and meanings are the same as specified for Informational Submittals.

1.07 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall review, coordinate, and verify submittals with Subcontractors, Manufacturers, and Suppliers, including field measurements at Site, in accordance with the General Conditions and as modified by Supplemental Conditions prior to submitting material for Engineer's review.
- B. Contractor shall clearly and concisely indicate, and mark equipment and material being submitted to meet the intent of the Contract Documents. Equipment and material not

being submitted shall be deleted, stricken through, or otherwise designated not being submitted. Equipment and material data sheets shall be included once with cross references throughout the submittal. Multiple equipment and material data sheets for the same item within a submittal may receive a rejected disposition until corrected.

1. Individual Specification Sections require a Compliance, Deviations, and Exceptions (CD&E) letter to be included with the submittal. When specified, submittals provided without the CD&E letter shall receive a rejected disposition without review.
2. CD&E letter requirements:
 - a. Include a copy of entire Specification section with each paragraph and subparagraph noted with "C", "D", or "E" to indicate if equipment and material being provided is in compliance (C), deviates (D), or exceptions (E) are taken with the Contract Documents.
 - 1) Compliance (C): Full compliance with the specified requirement.
 - 2) Deviation (D): Deviation from the specified requirement.
 - 3) Exception (E): Exception with the specified requirement.
 - b. Include all comments, deviations and exceptions taken to the Contract Documents by the Contractor and Equipment Manufacturer/Supplier.
 - c. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable.
 - d. Address deviations and exceptions taken to each Contract Drawing related to the Specification section.
- C. Contractor shall provide Contractor's stamp of approval certifying submittal material has been reviewed and conform to the Contract Documents prior to submitting material for Engineer's review.
- D. Contractor shall provide written notice of deviations or variations that submittal may have with the Contract Documents.
- E. Contractor shall provide bound, dated, labeled, tabulated, and consecutively numbered submittals as specified in the individual Specification Section. Label shall contain the following:
 1. Specification Section.

2. Referenced Drawing number.
 3. Subcontractor or Supplier name.
 4. Type of equipment and/or materials.
- F. Contractor shall perform the following after receiving Engineer's review disposition:
1. Order, fabricate, or ship equipment and materials included in the submittal (pending Engineer's review of source quality control submittals) with the following disposition:
 - a. "Furnish as Submitted" (FAS).
 - b. "Furnish as Corrected" (FAC).
 - c. "Furnish as Corrected – Confirm" (FACC), only portions of Work that do not require resubmittal for Engineer's review.
 2. Resubmittal requirements:
 - a. Partial resubmittal of "Furnish as Corrected – Confirm" (FACC) returned dispositions, until Engineer's disposition is either "Furnish as Submitted" (FAS) or "Furnish as Corrected" (FAC).
 - b. Full resubmittal of material with Engineer's disposition of "Revise and Resubmit" (R&R), until Engineer's disposition is "Furnish as Submitted" (FAS), "Furnish as Corrected" (FAC), or "Furnish as Corrected – Confirm" (FACC) that requires a partial resubmittal.
 - c. Contractor shall be responsible for Engineer's charges to Owner if submittals are not approved within the number of specified submittals in accordance with the General Conditions. Engineer's charges shall include, but not limited to, additional review effort, meetings, and conference calls with Contractor, Subcontractor, or Supplier.

1.08 ENGINEER'S REVIEW

- A. Engineer's review of the Contractor's submittal shall not relieve Contractor's responsibility under the Contract Document in accordance with the General Conditions and as modified in the Supplemental Conditions. An acceptance of a submittal shall be intended to mean the Engineer does not have specific objection to the submitted material, subject to conformance with the Contract Drawings and Specifications.
- B. Engineer's review of Contractor's submittal shall be confined to general arrangement and compliance with the Contract Documents, and shall not be for the purpose of

checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of Subcontractor work, etc.

C. Review Dispositions:

1. "Furnish as Submitted" (FAS) – No exceptions are taken.
2. "Furnish as Corrected" (FAC) – Minor corrections are noted for Contractor's correction.
3. "Furnish as Corrected – Confirm" (FACC) – Corrections are noted and partial resubmittal shall be made as noted.
4. "Revise and Resubmit" (R&R) – Corrections are noted and complete resubmittal shall be made. Submittal does not conform to applicable requirements of the Contract Documents and is not acceptable. Revise submittal and re-submit to indicate acceptability and conformance with the Contract Documents.
5. "Receipt Acknowledged" (RA) –
 - a. Information included in submittal conforms to the applicable requirements of the Contract Documents and is acceptable. No further action by Contractor is required relative to this submittal, and the Work covered by the submittal may proceed, and products with submittals with this disposition may be shipped or operated, as applicable.
 - b. Information included in submittal is for Project record purposes and does not require Engineer's review or approval.
6. "Rejected" (R) – Information included in submittal does not conform to the applicable requirements of the Contract Documents and is unacceptable. Contractor shall submit products and materials as specified in the Contract Documents or provide required information for substitution as specified in the Contract Documents for consideration by Engineer.

D. Electronic Submittal Return to Contractor: Electronic submittals shall be returned electronically with dispositions provided.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

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SECTION 01 35 20
CONFINED SPACE ENTRY PLAN

PART 1 – GENERAL

1.01 SUMMARY

- A. Owner has determined that portions of the Site may constitute confined spaces or permit-required confined spaces, as defined in this Section.
- B. Contractor shall provide appropriate measures, including labor, supervision, equipment, protective devices, and incidentals, to protect the health and safety of personnel at the Site relative to confined spaces, and who may be affected by the Work in confined spaces including, without limitation: employees and agents of Contractor, Subcontractors, Suppliers, Owner, and Engineer, while engaged in performance of their respective duties at Site.
- C. Comply with requirements of Owner’s confined space entry program, if any.

1.02 REFERENCES

- A. Definitions: The following words or terms are not defined but, when used in this Section, have the following meaning:
 - 1. “Confined spaces” are areas on or about the Site as defined in 29 CFR 1910.146(b) and 29 CFR 1926.1202. Confined spaces include, but are not limited to: storage tanks, process vessels, bins, boilers and similar spaces; ventilation or exhaust ducts and stacks; manholes, underground utility vaults and chambers, sewers, pipelines, tunnels; and open-topped spaces greater than four feet deep, such as pits, tubs, vaults, and vessels.
 - 2. “Entry permit” means the written or printed document provided by the employer of personnel entering permit-required confined space, to allow and control entry into permit-required confined space and that contains the information specified in 29 CFR 1910.146(f) and 29 CFR 1926.1206.
 - 3. “Permit-required confined space” means confined space as defined in 29 CFR 1926.146(b) and 29 CFR 1926.1202 and that has one or more of the following characteristics:
 - a. Contains or has potential to contain a hazardous atmosphere.
 - b. Contains material that has potential for engulfing an entrant.

- c. Has internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or floors, or by floor that slopes downward and tapers to a smaller cross-section.
 - d. Contains other recognized serious safety or health hazard.
 - 4. "Hot work permit" means the written authorization of employer of personnel entering a confined space to perform operations, such as riveting, welding, cutting, burning, and heating, capable of providing a source of ignition.
 - 5. "Host Employer" means the employer that owns or manages the property where construction is taking place.
 - 6. "Controlling Contractor" is the employer that has overall responsibility for construction at the worksite.
- B. Reference Standards: Comply with Laws and Regulations related to protecting personnel working in or entering confined spaces, including:
- 1. Code of Federal Regulations (CFR), Title 29, Part 1910, Occupational Safety and Health Standards.
 - 2. CFR, Title 29, Part 1926, Safety and Health Regulations for Construction.

1.03 PLAN REQUIREMENTS

- A. Review host employer's existing confined space inventory and entry procedures, if available, in order to prepare Site- and task-specific confined space entry plans which shall be incorporated into Contractor's Site-specific health and safety plan. Maintain copy of the confined space entry plan at the Site for access by employees, Owner and authorities having jurisdiction. Confined space entry plan shall include:
- 1. Results of Contractor's Site-specific hazard assessment to identify confined spaces that are permit-required confined spaces, including list of all such spaces that will be accessed for the Work. Update the list as required throughout the Project.
 - 2. Requirements for safeguarding access to, and restricting non-permitted personnel from access to, permit-required confined spaces during the Work.
 - 3. Project-specific procedures to be followed when entering or accessing permit-required confined spaces.
 - 4. Documentation of training provided to each person that will enter, or work in conjunction with entry to, permit-required confined spaces

5. Update the plan by adding copies of permits issued and records of entry to permit-required confined spaces, as required in this Section.

B. Confined Space Safety:

1. Personnel entering confined space shall be trained in accordance with 29 CFR 1926.1207 and 29 CFR 1910.146(g).
2. Comply with 29 CFR 1926 Subpart AA and requirements of authorities having jurisdiction.
3. Recordkeeping: Using forms required by Contractor, Owner, or authority having jurisdiction, issue for each instance of access to permit-required confined space, completed permit(s) and complete associated data sheet. File completed permits and data sheets in the Site-specific confined space entry plan and submit in accordance with this Section.
 - a. Permit for entry to permit-required confined space(s).
 - b. Permit for hot work in permit-required confined space(s).
 - c. Complete confined space data sheet.

1.04 SUBMITTALS

- A. If acceptable, written response for Submittals required in this Section will not be returned to Contractor.
- B. Submit the following to Owner; if submittals under this Section are furnished to Engineer, Engineer will forward all submittals under this Section to Owner without review.
 1. Procedures: Site-specific confined space entry plan, submitted upon request of Owner.
 2. Permits and Reports: For each time personnel enter a confined space, copies of completed permits required for confined space entry, and completed confined space data sheets, submitted upon request of Owner.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 42 00

REFERENCES

PART 1 – GENERAL

1.01 SUMMARY

- A. Definitions and terminology applicable to all the Contract Documents are included in the General Conditions and Supplementary Conditions.

1.02 REFERENCES

- A. Abbreviations and Acronyms: Common abbreviations that may be found in the Contract Documents are listed below:

alternating current	a-c
ampere	A
Architectural Barriers Act	ABA
Americans with Disabilities Act	ADA
Americans with Disabilities Act Accessibility Guidelines	ADAAG
ante meridian	a.m.
average	avg
biochemical oxygen demand	BOD
brake horsepower	bhp
British thermal unit	Btu
Centigrade (or Celsius)	C
chlorinated polyvinyl chloride	CPVC
Code of Federal Regulations	CFR
cubic inch	cu in
cubic foot	cu ft
cubic yard	cdu yd, or CY
cubic feet per minute	cfm
cubic feet per second	cfs

degree Centigrade (or Celsius)	degrees C or °C
degrees Fahrenheit	degrees F or °F
diameter	dia
direct current	d-c
dollars	\$
each	ea
efficiency	eff
Fahrenheit	F
feet	ft
feet per hour	fph
feet per minute	fpm
feet per second	fps
figure	Fig
flange	flg
foot-pound	ft-lb
gallon	gal
gallons per hour	gph
gallons per minute	gpm
gallons per second	gps
gram	g
grams per liter	g/L
Hertz	Hz
horsepower	hp or HP
hour	hr
human-machine interface	HMI
inch	in.
inches water gage	in. w.g.
inch-pound	in.-lb

inside diameter	ID
iron pipe size	IPS
thousand pounds	kips
thousand pounds per square inch	ksi
kilovolt-ampere	kva
kilowatt	kw
linear foot	lin ft or LF
liter	L
maximum	max
mercury	Hg
milligram	mg
milligrams per liter	mg/l or mg/L
milliliter	ml
millimeter	mm
million gallons per day	mgd or MGD
million gallons	MG
minimum	min
national pipe threads	NPT
net positive suction head	NPSH
net positive suction head available	NPSHA
net positive suction head required	NPSHR
nominal pipe size	NPS
number	no.
operator interface terminal	OIT
ounce	oz
ounce-force	ozf
outside diameter	OD
parts per hundred	pph

parts per million	ppm
parts per billion	ppb
polyvinyl chloride	PVC
post meridian	p.m.
pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia
pounds per square inch gauge	psig
pounds per square foot	psf
process control system	PCS
programmable logic controller	PLC
revolutions per minute	rpm
second	sec
specific gravity	sp gr or SG
square	sq
square foot	sq ft or sf
square inch	sq in.
square yard	sq yd or SY
standard	std
standard cubic feet per minute	scfm
total dynamic head	TDH

B. Definitions: Terminology used in the Specifications includes:

1. "Indicated" refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs or schedules in the Specifications and similar locations in the Contract Documents.
2. "Shown", "noted", "scheduled", and "specified" are used to help the user locate the reference without limitation on the location.

3. “Installer”, “applicator”, or “erector” is Contractor or another entity engaged by Contractor, either as an employee or subcontractor, to perform a particular construction activity, including installation, erection, application or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.
4. “Experienced”, when used with the term “installer” means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with requirements of the Supplier of the material or equipment being installed.
5. Trades: Use of a term such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”, unless otherwise indicated in the Contract Documents or required by Laws or Regulations. Such terminology also does not imply that specified requirements apply exclusively to trade personnel of the corresponding generic name.
6. “Assigned specialists” and similar terms: Certain Sections of the Specifications require that specific construction activities be performed by specialists recognized as experts in those operations. Engage said specialists for those activities, and their engagement is a requirement over which Contractor has no option. These requirements do not conflict with enforcement of building codes and other Laws and Regulations. Also, such requirements are not intended to interfere with local trade union jurisdictional settlements and similar conventions. Such assignments shall not relieve Contractor of responsibility for complying with the requirements of the Contract Documents.

C. Reference Standards:

1. Refer to General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents. Provisions of reference standards are in effect in accordance with the Specifications.
2. Copies of Standards: Each entity engaged in the Work shall be familiar with reference standards applicable to its construction activity. Copies of applicable reference standards are not bound with the Contract Documents. Where reference standards are needed for a construction activity, obtain copies of standards from the publication source.
3. Abbreviations and Names: Where reference standards, specifications, codes, manuals, Laws or Regulations, or other published data of international, national, regional or local organizations are referred to in the Contract Documents, the

organization issuing the standard may be referred to by their acronym or abbreviation only.

4. Following acronyms or abbreviations that may appear in the Contract Documents shall have the meanings indicated below. Listing is alphabetical by acronym.

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACIFS	American Cast Iron Flange Standards
ACS	American Chemical Society
ADC	Air Diffusion Council
ADSC	International Association of Foundation Drilling.
AEIC	Association of Edison Illuminating Companies
AF&PA	American Forest and Paper Association
ABMA	American Bearing Manufacturers Association (formerly Anti- Friction Bearing Manufacturers Association (ABMA))
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHDGA	American Hot Dip Galvanizers Association
AI	Asphalt Institute
AIA	American Institute of Architects
AIChE	American Institute of Chemical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMA	Acoustical Materials Association
AMCA	Air Movement and Control Association

AMP	National Association of Architectural Metal Manufacturers, Architectural Metal Products Division
ANSI	American National Standards Institute
APA	The Engineered Wood Association
API	American Petroleum Institute
APHA	American Public Health Association
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASA	American Standards Association
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASQ	American Society for Quality
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWCI	Association of the Wall and Ceiling Industry
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BAAQMD	Bay Area Air Quality Management District
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association
BOCA	Building Officials and Code Administrators
CBMA	Certified Ballast Manufacturers Association
CDA	Copper Development Association

CEMA	Conveyor Equipment Manufacturers Association
CGA	Compressed Gas Association
CISCA	Ceilings and Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CMAA	Crane Manufacturers Association of America
CPSC	Consumer Product Safety Commission
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DDW	Division of Drinking Water
DIN	Deutsches Institut für Normung eV (German Institute for Standardization)
DIPRA	Ductile Iron Pipe Research Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ETL	Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.)
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FM	Factory Mutual (FM Global)
FRPI	Fiberglass Reinforced Plastics Institute
FS	Federal Specification
GA	Gypsum Association
GANA	Glass Association of North America
HEW	United States Department of Health, Education and Welfare
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
HUD	United States Department of Housing and Urban Development

IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFI	Industrial Fasteners Institute
IFCEA	Insulated Power Cable Engineers Association
IRI	Industrial Risk Insurers
ISA	Instrumentation, Systems, and Automation Society (formerly Instrument Society of America)
ISO	Insurance Services Office
IOS	International Organization for Standardization
LPI	Lightning Protection Institute
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
MSS	Manufacturers' Standardization Society
MMA	Monorail Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators, Inc.
NARUC	National Association of Regulatory Utilities Commissioners
NBHA	National Builders Hardware Association
NBS	United States Department of Commerce, National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electric Code
NELMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association

NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NHPMA	Northern Hardwood and Pine Manufacturers Association
NIST	United States Department of Commerce, National Institute of Standards and Technology
NLGA	National Lumber Grades Authority
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSSGA	National Stone, Sand, and Gravel Association
NTMA	National Terrazzo and Mosaic Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PEI	Porcelain Enamel Institute
PFI	Pipe Fabrication Institute
PPI	Plastics Pipe Institute
PGMC	Primary Glass Manufacturers Council
PS	Product Standards Section, United States Department of Commerce
RCSC	Research Council on Structural Connections (part of AISC)
RMA	Rubber Manufacturers Association
SAE	Society of Automotive Engineers
SBCCI	Southern Building Code Congress International, Inc.
SCAQMD	Southern California Air Quality Management District
SCPRF	Structural Clay Products Research Foundation

SCTE	Society of Cable Telecommunications Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SPI	Society of the Plastics Industry
SPIB	Southern Pine Inspection Bureau
SSPC	Society for Protective Coatings
SWI	Steel Window Institute
TCNA	Tile Council of North America
TEMA	Tubular Exchanger Manufacturers Association
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UDOT	Utah Department of Transportation
USAB	United States Access Board
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGBC	United States Green Building Council
USGS	United States Geological Survey
USPHS	United States Public Health Service
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCMA	Wood Component Manufacturers Association
MDMA	Window and Door Manufacturers Association
WWEMA	Water and Wastewater Equipment Manufacturers Association
WWPA	Western Wood Products Association

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 23
TESTING SERVICES FURNISHED BY CONTRACTOR

PART 1 – GENERAL

1.01 SUMMARY

- A. This specification addresses requirements for testing services specifically required to be provided by the Contractor. This section does not apply to any testing required to be provided by the Owner or Owner’s representative.
- B. This section does not apply to any Special Inspections as required by Section 01 45 33. Special Inspections cannot be provided by the Contractor in accordance with the Governing Building Code.
- C. Contractor shall employ and pay for independent testing entity to perform specified services covered by this specification. Entity selected shall be subject to approval by Engineer.
- D. Inspection, sampling, and testing shall be as specified in the individual Specification Sections.
- E. Related Sections, but not limited to, the following:
 - 1. Section 01 45 33 – Special Inspections
 - 2. Section 01 88 16 – Watertightness Testing of Concrete Structures
 - 3. Section 31 00 01 – Earthwork
 - 4. Section 31 05 16 – Aggregate Materials
 - 5. Section 31 23 24 – Flowable Fill
 - 6. Section 32 10 00 – Paving and Surfacing
 - 7. Section 33 05 61 – Utility Structures
 - 8. Section 03 21 00 – Reinforcing Steel.
 - 9. Section 03 30 00 – Cast-in-Place Concrete
 - 10. Section 07 13 50 – Waterproofing

1.02 ADMINISTRATIVE REQUIREMENTS

A. Contractor's Responsibilities:

1. Provide to laboratory representative samples of materials to be tested, in required quantities.
2. Provide labor and facilities:
 - a. To provide access to the Work to be tested, and where required, to Suppliers' operations.
 - b. To obtain and handle samples at the Site.
 - c. To facilitate inspections and tests.
 - d. For testing entity's exclusive use for storage and curing of test samples.
 - e. Forms for preparing concrete test beams and cylinders.
3. Notify testing entity and Engineer sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
4. Arrange with testing entity and pay for additional services, sampling, and testing required for Contractor's convenience.
5. Provide to testing entity the preliminary design mix proposed for concrete, and other material mixes that require testing by the testing laboratory.

B. Testing Entity's Responsibilities:

1. Cooperate with Contractor and Engineer and provide qualified personnel promptly when notified.
2. Perform specified inspections, sampling, and testing of materials and methods of construction; comply with applicable standards; ascertain compliance with requirements of the Contract Documents.
3. Promptly notify Engineer and Contractor of irregularities or deficiencies in the Work observed during performance of services.
4. Submit specified quantity of report copies of inspections and tests to Contractor and Engineer.
5. Perform additional tests and services as required to ensure compliance with the Contract Documents.

C. Report Requirements:

1. Electronic Submittal of testing reports.
2. Include the following information:
 - a. Date issued.
 - b. Project title, number, and name of the Site.
 - c. Testing laboratory name and address.
 - d. Name and signature of inspector or person obtaining samples.
 - e. Date of inspection or sampling.
 - f. Record of temperature and weather.
 - g. Date of test.
 - h. Identification of material or product tested and associated Specification Section.
 - i. Location in the Project.
 - j. Type of inspection or test.
 - k. Results of tests and observations regarding compliance with the Contract Documents.

1.03 SUBMITTALS

- A. Submit copies of material and product test reports where required by the Contract Documents and as requested by Engineer.
- B. Quality Assurance Submittals:
 1. Qualifications statement indicating experience and facilities for tests required under the Contract Documents.
 2. Copy of report of inspection of facilities during most recent NIST inspection tour. Include memorandum of remedies of deficiencies reported during inspection.
 3. Copy of certificate of calibration for each instrument or measuring device proposed for use, by accredited calibration agency.

1.04 QUALIFICATIONS

- A. Comply with applicable requirements of ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. Laboratory shall be authorized to operate in the same State or Commonwealth as the Site. Where applicable, laboratory shall be certified by the authority having jurisdiction for the types of testing required.
- C. Testing equipment used by laboratory will be calibrated at maximum twelve-month intervals by devices of accuracy traceable to either NIST's Standard Reference Materials (SRM), ISO 17025, General Requirements for the Competence of Testing and Calibration Laboratories, or certified by State, Commonwealth, or local bureau of weights and measures, or values of natural physical constants generally accepted in the engineering and scientific community.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. This Section defines the requirements for Special Inspections as required by Section 1704 of the International Building Code (IBC) and any State or local amendments.
- B. Either the Engineer of Record (EOR) or Registered Design Professional in Responsible Charge (RDPIRC) will prepare a Statement of Special Inspections, which identifies the type and extent of required Special Inspections.
- C. The Owner will retain one or more Special Inspections Agencies to perform Special Inspection services. These Agencies shall be independent from the Contractor and approved by the Building Official. The EOR may perform Special Inspection services where qualifications for a specific inspection task are met.
- D. The Contractor shall plan and conduct operations as to schedule and allow Special Inspections, providing adequate time and safe access for inspections. The Contractor shall coordinate requirements for Special Inspections with the Special Inspections Agency.
- E. Special Inspections shall be in addition to inspections performed by Building Officials that are specified in IBC Section 104.
- F. Special Inspections shall be in addition to any Structural Observations required by IBC Section 1704.6.
- G. Special Inspections do not supersede other inspections and testing required by the Contract Documents to satisfy the Contractor's quality control responsibility. Contractor shall be responsible for all costs associated with quality control requirements as required by other Sections of the Specifications.
- H. Special Inspections shall not relieve Contractor's obligation to perform and complete work in accordance with Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- I. This Section does not apply to construction equipment, shoring, earth retention systems, and temporary structures used by the Contractor in construction and not detailed in the Contract Documents. The Contractor shall be solely responsible for means, methods,

techniques, sequences, or procedures of construction and any associated building code requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Special Inspections requirements apply to work detailed in other Sections of the Specifications. Special Inspections requirements shall be in addition to any other inspection or quality control requirements detailed in other Sections of the Specifications. See individual Specification Sections for type of work in question.

1.03 DEFINITIONS

- A. Periodic Special Inspections: The part-time or intermittent observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.
- B. Continuous Special Inspections: The full-time observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work is being performed.
- C. Engineer of Record (EOR): The engineer of each system in responsible charge for the design of each specific building system including structural, mechanical, electrical, and architectural components
- D. Registered Design Professional in Responsible Charge (RDPIRC): The RDPIRC in charge of Special Inspections during construction for each specific building system including structural, mechanical, electrical, and architectural components. The RDPIRC shall be a currently Registered Professional Engineer in the State or Commonwealth in which the project is located. The EOR may serve in this role.
- E. Special Inspections Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The EOR may serve in this role where qualifications for specific inspection tasks are met.
- F. Special Inspector: Individual employed by or retained by the Special Inspections Agency who is qualified in inspection of specific aspects or components of the construction and conducts inspection activities in these specific aspects of the construction, as required by this Section. The EOR may serve in this role where qualifications for specific inspection tasks are met.
- G. Statement of Special Inspections: Document prepared by the EOR or RDPIRC and submitted to the Building Official which identifies the type and extent of required Special Inspections.

- H. Approved Fabricator: Fabricator who has been registered and approved by the Building Official to manufacture or fabricate specific components of the construction without Special Inspections.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents and all other documents referenced in the Specifications. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. International Building Code
 - 2. ACI 318 – Building Code Requirements for Structural Concrete
 - 3. TMS 402/TMS 602 – Building Code for Masonry Structures/Specifications for Masonry Structures
 - 4. AISC – Code of Standard Practice
 - 5. AISC 341 – Seismic Provisions for Structural Steel Buildings
 - 6. AISC 360 – Specification for Structural Steel Buildings
 - 7. AISC 348 – Specification for Structural Joints Using High Strength Bolts
 - 8. AWS – Structural Welding Code
 - 9. ADMI – Aluminum Design Manual: A Specification for Aluminum Structures

1.05 SUBMITTALS

- A. The Contractor shall submit the following in accordance with Section 01 33 00 - Submittal Procedures.
 - 1. The Contractor shall submit a written statement of responsibility to the Building Official and RDPIRC prior to beginning work. A statement is required from each Contractor who has responsibility for construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections.
 - 2. The Contractor shall submit qualifications of any fabricators they intend to use that may qualify as Approved Fabricators to the Special Inspections Agency for review.

- B. The Special Inspections Agency shall submit the following in accordance with Section 01 33 00 – Submittal Procedures.
1. The Special Inspections Agency shall provide a statement of qualifications showing relative experience, training, and certification(s) for each Special Inspector to the Building Official, if requested.
 2. The Special Inspections Agency shall review fabricator qualifications and submit them to the Building Official for approval as an Approved Fabricator if requested.
 3. Special Inspectors shall keep detailed inspection records, including all inspections, tests, similar services, and any discrepancies and corrections. Any discrepancies and corrections shall be reported to the Building Official, the EOR, and the RDPIRC in all required reports, unless otherwise required by the Building Official.
 4. The Special Inspections Agency shall submit Interim Reports to the Building Official and the RDPIRC documenting required Special Inspections and correction of any discrepancies at the frequency specified in the Statement of Special Inspections.
 5. The Special Inspections Agency shall submit to the Building Official and the RDPIRC a Final Report documenting required Special Inspections and correction of any discrepancies. The Final Report shall be submitted at a point in time agreed upon by the Owner and the Building Official at the Pre-inspection Meeting.
 6. Where work is done by Approved Fabricators, the Special Inspections Agency shall coordinate the submittal of a certificate of compliance to the Building Official, the EOR, and the RDPIRC.

1.06 SPECIAL INSPECTOR QUALIFICATIONS

- A. Special Inspectors shall meet minimum qualifications established by the Building Official and shall be approved by the Building Official.

1.07 OFF-SITE FABRICATIONS

- A. When structural elements or assemblies are fabricated off site, Special Inspections shall be performed in the fabricator's shop unless the fabricator is an Approved Fabricator. Special Inspections are not required if work is done on the premises of an Approved Fabricator.
- B. Fabricators shall maintain detailed fabrication and quality control procedures to ensure workmanship and conformance with Contract Documents and reference standards. The

Special Inspections Agency shall review the fabricator's quality control procedures and coordinate required Special Inspections with the fabricator and the Contractor.

- C. The Contractor shall submit qualifications of fabricators seeking Approved Fabricator status to the Special Inspections Agency for review. Approval as an Approved Fabricator shall be given by the Building Official upon the recommendation of the Special Inspections Agency or upon review of the fabricator's written fabrication procedures and quality control manuals that provide a basis for control of materials and workmanship, with periodic auditing of fabrication and quality control practices by an Approved Agency or the Building Official.
- D. At completion of fabrication, the Approved Fabricator shall submit a certificate of compliance to the Owner or the RDPIRC for submittal to the Building Official stating that the work was performed in accordance with the approved Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PRE-INSPECTION MEETING

- A. At least two weeks prior to beginning work, a Pre-inspection Meeting shall be held to discuss the Special Inspection procedures and submittals. The following parties shall participate: EOR, RDPIRC, Special Inspections Agency representative, Contractor, Subcontractors, Testing Agencies, and Building Official. The type of meeting (in-person or teleconference) and location of meeting shall be determined by the Building Official.

3.02 STATEMENT AND SCHEDULE OF SPECIAL INSPECTIONS

- A. The Special Inspections Agency and all Special Inspectors are required to comply with all requirements of the Statement of Special Inspections and the Schedule of Special Inspections. Together, these documents identify materials, systems, components, and work that are required to have Special Inspections, the type and extent of Special Inspections, and whether they will be continuous or periodic. The Schedule of Special Inspections is included at the end of this Section. A form which may be used for the Statement of Special Inspections is also included at the end of this Section.

3.03 SPECIAL INSPECTIONS AGENCY REQUIREMENTS AND RESPONSIBILITIES

- A. The Special Inspections Agency shall be an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The Agency shall

demonstrate competence, to the satisfaction of the Building Official, for the inspection of the specific aspects of construction or operation requiring Special Inspection.

- B. The Special Inspections Agency shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Agency shall submit all required reports to the EOR, RDPIRC and Building Official. Where EOR approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all required reports. The Agency shall coordinate all required Special Inspection activities with the Special Inspectors, the Contractor, and any fabricators and shall coordinate designation of fabricators as Approved Fabricators when requested.

3.04 SPECIAL INSPECTORS' REQUIREMENTS AND RESPONSIBILITIES

- A. All Special Inspectors shall meet the qualification requirements determined by the Building Official for the specific type of inspection services they will be providing and shall be approved by the Building Official. Special Inspectors shall submit written documentation demonstrating their competence and experience or training to the Building Official for approval of their qualifications.
- B. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC, or the Building Official. Special Inspectors shall submit all required reports to the RDPIRC and the Building Official. Where EOR approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all required reports. Special Inspectors shall coordinate inspection requirements and time when inspections can be conducted with the Contractor.
- C. Any discrepancies in work noted by the Special Inspector shall be brought to the immediate attention of the Contractor for correction. Special Inspectors shall coordinate correction of discrepancies with the Contractor. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. If noted discrepancies are not corrected, the Special Inspector shall notify the Contractor, the EOR, the RDPIRC and the Building Official. All noted discrepancies and corrections shall be documented in all inspection records and all required reports.

3.05 CONTRACTOR RESPONSIBILITIES

- A. Each Contractor responsible for the construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections shall submit a

Statement of Responsibility to the Building Official, RDPIRC, and EOR prior to the commencement of work. The Statement of Responsibility shall contain acknowledgement of the specific requirements contained in the Statement of Special Inspections.

- B. The Contractor shall coordinate requirements of Special Inspections with the Special Inspections Agency and the Special Inspectors and shall provide adequate time and access to conduct inspections. The Contractor is solely responsible for providing safe access and any necessary safety equipment required to conduct inspections. The Special Inspector shall not supervise, direct, control, or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the Contractor to comply with Laws and Regulations applicable to the performance of the Work.
- C. Special Inspections shall not relieve the Contractor's obligation to perform and complete work in accordance with the Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.
- D. The Contractor shall provide advance notice of work to be conducted that will require Special Inspections. If the Special Inspector is delayed in inspecting the work due to inadequate notice or completion of the work, the Contractor shall reimburse the Owner for the cost of additional subsequent Special Inspections.
- E. The Contractor shall promptly correct any discrepancies noted by the Special Inspectors. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. Where EOR approval is required, the Contractor shall report the discrepancy to the EOR in accordance with provisions of the General Conditions. The EOR will authorize any changes to the Contract Documents required for the correction in accordance with provisions of the General Conditions. Copies of all correspondence related to the correction shall be submitted concurrently to the Special Inspections Agency.

3.06 BUILDING OFFICIAL OR AUTHORITY RESPONSIBILITIES

- A. The Building Official will approve qualifications of the Special Inspections Agency, all Special Inspectors, and any Approved Fabricators. The Building Official will approve all forms submitted by the Contractor, any Approved Fabricators, the EOR, the RDPIRC, the Special Inspections Agency, and the Special Inspectors. The Building Official and the Special Inspections Agency shall agree to the frequency of Interim Reports and the submittal deadline for the Final Report.

3.07 RDPIRC RESPONSIBILITIES

- A. The RDPIRC shall complete the Statement of Special Inspections and the Schedule of Special Inspections, unless previously completed by the EOR. The Statement of Special Inspections form included in this Section shall be used unless the Building Official has a preferred form for the Statement of Special Inspections, in which case the Building Official's form may be used and shall be completed by the RDPIRC.
- B. The RDPIRC shall review and coordinate certain aspects of the project, as determined by the Building Official, for compatibility with the design of the building, structure or building system, including, but not limited to, submittal documents prepared by others, deferred submittal documents and phased submittal documents.

3.08 OWNER RESPONSIBILITIES

- A. The Owner will retain a Special Inspections Agency to perform Special Inspections during construction. The Special Inspections Agency will retain the RDPIRC.

3.09 MINIMUM INSPECTION REQUIREMENTS

- A. Detailed requirements for Special Inspections are shown in the Statement of Special Inspections and the Schedule of Special Inspections, which references the IBC, applicable code standards, and any State or local amendments. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Additional requirements for specific materials listed in other Sections of these Specifications shall also be satisfied. The frequency of inspections shall be continuous or periodic as indicated in the Schedule of Special Inspections and in accordance with applicable building codes.

3.10 REPORTS

- A. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Special Inspections Agency shall submit all required reports to the Building Official, EOR, and RDPIRC as agreed upon with the Building Official. Reports shall indicate the inspections and testing performed and whether work inspected was or was not completed in conformance to Contract Documents and any corrective measures taken. Where EOR approval is required for corrections, the Agency shall maintain copies of all related correspondence and submit with all required reports.

3.11 SPECIAL INSPECTIONS FORMS

- A. This Section includes forms which may be used to meet requirements for written documentation during the performance of Special Inspections in accordance with the IBC. These forms may be replaced with forms meeting IBC requirements provided by the Building Official if available.

SCHEDULE OF SPECIAL INSPECTIONS (IBC 2021 VERSION)

2. – CONCRETE CONSTRUCTION (IBC 2021)

(Table 2 is applicable to cast-in-place concrete and precast concrete. See Table 4 for additional inspections for precast concrete.)

Inspection Task	Frequency		Applicable to project		Reference Standard ^e	IBC Reference
	CONT	PER	Y/N	Agent		
1. Inspect reinforcement, including prestressing tendons, and verify placement		X	Y		ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	1705.3
2. Reinforcing bar welding:					AWS D1.4, ACI 318: 26.6.4	1705.3
a. Verify weldability of reinforcing bars other than ASTM A706		X	N			
b. Inspect single-pass fillet welds, maximum 5/16"		X	N			
c. Inspect all other welds	X		N			
3. Inspect anchors cast in concrete		X	Y		ACI 318: 17.8.2	1705.3
4. Inspect anchors post-installed in hardened concrete members^f:	X				ACI 318:17.8.2.4, ACI 318: 17.8.2	1705.3
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads			N			
b. Mechanical anchors and adhesive anchors not defined in 4. a			Y			
5. Verify use of required design mix		X	Y		ACI 318: Ch 19, 26.4.3, 26.4.4	1705.3, 1904.1, 1904.2
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete	X		Y		ASTM C172, ASTM C31, ACI 318: 26.5, 26.12	1705.3
7. Inspect concrete and shotcrete placement for proper application techniques	X		Y		ACI 318: 26.5	1705.3
8. Verify maintenance of specified curing temperature and techniques		X	Y		ACI 318: 26.5.3-26.5.5	1705.3

Inspection Task	Frequency		Applicable to project		Reference Standard ^e	IBC Reference
	CONT	PER	Y/N	Agent		
9. Inspect formwork for shape, location, and dimensions of the concrete member being formed		X	Y		ACI 318: 26.11.1.2(b)	1705.3
^e Where applicable, see IBC Section 1705.13, Special Inspections for seismic resistance. ^f Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.						

8. SCHEDULE OF SPECIAL INSPECTIONS—SOILS (IBC 2021)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity		X	Y			1705.6
2. Verify excavations are extended to proper depth and have reached proper material		X	Y			
3. Perform classification and testing of compacted fill materials		X	Y			
4. During fill placement, verify use of proper materials and procedures in accordance with provisions of the approved geotechnical report. Verify densities and lift thicknesses during placement and compaction of compacted fill	X		Y			
5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly		X	Y			

9. Special Inspections Agency Contact Information:	
1.	
2.	
3.	
4.	

Building Official's Acceptance:

Type or print name

Signature

Date

STATEMENT OF SPECIAL INSPECTIONS
REQUIREMENTS FOR SEISMIC RESISTANCE

See the Schedule of Special Inspections for inspection and testing requirements.

Seismic Design Category: _____

Statement of Special Inspection for Seismic Resistance Required (Yes/No): _____

Description of seismic force-resisting system subject to special inspection and testing for seismic resistance:

N/A

Description of designated seismic systems in accordance with Chapter 13 of ASCE 7 subject to special inspection and testing for seismic resistance. Special inspector shall verify that the label, anchorage and mounting of these systems conforms to the Contract Documents and Approved Submittals:

N/A

Description of additional seismic systems and components requiring special inspections:

N/A

Description of additional seismic systems and components requiring testing:

N/A

Statement of Responsibility:

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

INTERIM REPORT OF SPECIAL INSPECTIONS

City/County of:							
Project Name/Address:				Inspection Type(s) Coverage:			
				<input type="checkbox"/> Continuous		<input type="checkbox"/> Periodic	
Describe Inspections Made, Including Locations:							
Tests Made:							
Total Inspection Time Each Day	Date:						
	Hours:						
<p>List items requiring Special Inspection, and any discrepancies and corrections. If Engineer approval is required for any corrections, note this, and indicate that approval was obtained. Attach copies of all related correspondence.</p> 							
Comments:							

To the best of my knowledge, work inspected was in accordance with the Contract Documents and applicable standards except as noted above.

Signed: _____ Date: _____

Print Full Name: _____ I.D.: _____

Phone Number: _____

This report is to be submitted to the Building Official and the Engineer. A copy shall be maintained at the jobsite.

FINAL REPORT OF SPECIAL INSPECTIONS

PROJECT: _____

LOCATION: _____

PERMIT APPLICANT: _____

APPLICANT'S ADDRESS: _____

ARCHITECT OF RECORD: _____

STRUCTURAL ENGINEER OF RECORD: _____

MECHANICAL ENGINEER OF RECORD: _____

ELECTRICAL ENGINEER OF RECORD: _____

REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE: _____

To the best of my information, knowledge, and belief, Special Inspections required for this Project in accordance with Section 1704 of the International Building Code and any State or local amendments have been performed, and all work has been completed in accordance with the Contract Documents and all applicable standards, except as indicated.

The Special Inspection program does not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

This Final Report includes information submitted in previous Interim Reports numbered _____ to _____, as well as any Special Inspections, discrepancies, and corrections occurring since the last Interim Report, dated _____.

All items requiring Special Inspection are listed below. All inspections, tests, and similar services that were performed are listed and any discrepancies and corrections are indicated. If Engineer approval was required for any corrections, this is noted, and copies of all related correspondence are attached.

(Attach 8 1/2"x11" continuation sheet(s) if required to complete the description of corrections)

Prepared By:

Special Inspection Agency:

Type or print name

Signature

Date



CONTRACTOR'S STATEMENT OF RESPONSIBILITY

Each Contractor responsible for the construction or fabrication of a main-wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections must submit this Statement of Responsibility prior to commencement of work on the system or component.

Project: _____

Contractor's Name: _____

Address: _____

License No.: _____

Description of building systems and components included in Statement of Responsibility:

Contractor's Acknowledgement of Special Requirements

I hereby acknowledge that I have received, read, and understand the Statement of Special Inspections and its requirements.

Name and Title (type or print)

Signature

Date

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per Section 1704 of the International Building Code must submit this Fabricator's Certificate of Compliance at the completion of fabrication.

Project: _____

Fabricator's Name: _____

Address: _____

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated on my premises in strict accordance with the Contract Documents and applicable standards.

Name and Title (type or print)

Signature

Date

Attach copy of Building Official's approval of fabricator as an Approved Fabricator.

NOTIFICATION OF FAILURE TO CORRECT DISCREPANCY

City/County of:
Project Name/Address:
List discrepancies, proposed correction, and Contractor response. If Engineer approval is required for any corrections, note this, and indicate whether approval was obtained. Attach copies of all related correspondence.
Comments:

Signed: _____ Date: _____

Print Full Name: _____ I.D.: _____

Phone Number: _____

This report is to be submitted to the Building Official, the Contractor, and the Engineer.

END OF SECTION

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SECTION 01 55 00
CONTRACTOR ACCESS AND PARKING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Contractor shall provide and maintain temporary laydown and employee parking areas and appurtenances required during the Project for use by Contractor, other contractors employed on the Project, Owner's, and emergency vehicles, as shown on the Drawings.
2. Laydown and employee parking areas shall be designed and maintained by Contractor and shall be fully passable to vehicles in all weather conditions.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Access roads:

1. Contractor shall construct and maintain such temporary access roads as required to perform the Work.
2. Contractor shall construct access roads, where possible, in locations over the areas of future road systems.
3. Access roads shall be located within the property lines of the Owner unless the Contractor independently secures easements for use and convenience.
 - a. Contractor shall submit written documentation to the Engineer for Contractor secured easements across privately held property.
 - b. Easement agreements shall specify terms and conditions of use and provisions for Site restoration.
 - c. Written release from property owner certifying that terms of the easement agreement have been complied by the Contractor shall be furnished to the Engineer prior to final payment.

B. Use of existing access roads:

1. Contractor will be allowed to use Owner's existing roads as shown on the Drawings.

2. Prevent interference with traffic on existing roads and parking areas. At all times, keep access roads and entrances serving the Site clear and available to Owner, Owner's employees, emergency vehicles, and other contractors. Do not use access roads or Site entrances for parking or storage of materials or equipment.
3. Contractor shall indemnify and hold harmless Owner and Engineer from expenses caused by Contractor's operations over existing roads and parking areas.
4. Schedule deliveries to minimize use of driveways and Site entrances.
5. Contractor shall suitably maintain existing access road at Contractor's expense for the duration of the Contract time.

C. Contractor parking areas:

1. Contractor employee vehicles shall park in area(s) designated by Owner or as shown on the Drawings.
2. Contractor shall construct and maintain parking area at the Site.

D. State/Commonwealth and local regulations:

1. Contractor shall obtain and pay all cost associated with bonds required by authorized entity (i.e. State or Commonwealth Department of Transportation) for the use of State or Commonwealth maintained roads.
2. Contractors shall obey traffic laws and comply with requirements, rules and regulations of the authorized entity (i.e. State or Commonwealth Department of Transportation), including local authorities having jurisdiction, to maintain warning signs, lights, barriers, etc. for the protection of traffic on public roadways.

E. Site security:

1. Contractor shall safely guard all the Work, the Project, products, equipment, and property from loss, theft, damage, and vandalism until Substantial Completion. Contractor's duty includes safely guarding Owner's property in vicinity of the Work and Project, and other private property in the vicinity of the Project from injury and loss in connection with performance of the Project.
2. Employ watchmen as required to provide required security and prevent unauthorized entry.
3. Costs for security required under this Section shall be paid by Contractor.
4. Make no claim against Owner for damage resulting from trespass.

5. Pay full compensation for, or repair or replace, damage to property of Owner and others arising from failure to furnish adequate security.
6. Provide temporary fencing in accordance with the Contract Documents.
7. Security requirements specified in the Section shall begin as soon as the contractor delivers materials to the Site and/or begins work and shall continue until the date of Final Completion.
8. Procedures:
 - a. Contractor shall conform to Owner's security procedures and access restrictions at Site throughout entire Project.
 - b. Contractor, including Subcontractors and Suppliers, shall comply with the following:
 - 1) Personnel Identification: All Contractor personnel shall wear at all times on-Site a badge bearing Contractor's name, employee's name and, as applicable, employee number.
 - 2) Parking: Do not park outside of designated Contractor parking area, which is shown on the Drawings. Prepare and maintain parking area as required. Personal vehicles are not allowed outside Contractor parking area.
9. Contractor shall provide and maintain temporary security fencing if existing security fencing or barriers are breached or temporarily removed for the Project at no additional cost to the Owner. Temporary security fencing shall be equal to existing, unless otherwise specified, and provided and maintained in a manner satisfactory to Engineer and Owner.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Contractor shall determine if and where temporary fencing is necessary, unless existing security fencing is damaged, which will be determined by Engineer and Owner.
- B. Install temporary fencing used for site security in accordance with the Contract Documents and fence manufacturer's instructions. Provide temporary fencing for site security so that integrity of site security is maintained throughout the Project.

- C. Maintain temporary fencing. Repair damage to temporary fencing and replace fencing when required to maintain site security.
- D. Remove temporary fencing when permanent site security fencing is in place and fully functional, or when otherwise directed by Owner or Engineer.

END OF SECTION

SECTION 01 71 33
PROTECTION OF WORK AND PROPERTY

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Protection of existing utilities and structures.
 2. Protection of installed equipment and materials.
 3. Protection during inclement weather.
 4. Reporting of accidents.
 5. Barricades and warning signals.
- B. Contractor shall be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage, as specified in the General Conditions, Supplementary Conditions, and this Section.
- C. To prevent damage, injury, or loss, Contractor's actions shall include the following:
1. Storing apparatus, materials, supplies, and equipment in an orderly, safe manner that does not unduly interfere with progress of the Work or work of other contractors or utility companies.
 2. Providing suitable storage facilities for equipment and materials subject to damage or degradation by exposure to weather, theft, breakage, or other cause.
 3. Placing upon the Work or any part thereof only loads consistent with the safety and integrity of that portion of the Work and existing construction.
 4. Frequently removing and disposing of refuse, rubbish, scrap materials, and debris caused by Contractor's operations so that, at all times, the Site is safe, orderly, and workmanlike in appearance.
- D. Contractor has full responsibility for preserving public and private property and facilities on and adjacent to the Site. Direct or indirect damage done by, or on account of, any act, omission, neglect, or misconduct by Contractor in executing the Work, shall be restored by Contractor, at their expense to condition equal to that existing before damage was done.

- E. Contractor shall comply with safety regulations required by Owner or authorities having jurisdiction. Contractor shall comply with and correct unsafe conditions created or caused by Contractor's personnel. In the event Contractor fails to comply, Owner receives the right to take necessary measures to correct conditions or practices for reimbursement by Contractor.

1.02 REFERENCES

A. Definitions:

1. "Existing utilities" shall refer to both publicly-owned and privately-owned utilities such as, but are not limited to, electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.
2. "Surface structures" are existing buildings, structures, and other facilities at or above ground surface, including their foundations or any extension below ground surface. Surface structures include, but are not limited to, buildings, tanks, walls, channels, open drainage, exposed piping and utilities, poles, exposed wires, posts, signs, markers, curbs, walks, fencing, and other facilities visible at or above ground surface.

1.03 SITE CONDITIONS

A. Location of Existing Utilities and Structures:

1. Contractor shall confirm and verify location of existing utilities and structures at the Site prior to commencing the Work.
2. Contractor shall notify and obtain approval from authority having jurisdiction prior to performing the Work in the vicinity of the existing utilities and structures.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. General:

1. Contractor shall satisfy Engineer that methods and procedures for protection have been approved by authorities having jurisdiction prior to proceeding with the Work.
2. Contractor shall provide temporary support and protection, as required, to existing utilities and structures during the Work, including support of excavation.

- a. Temporary support and protection of existing utilities shall be provided in accordance with requirements of the authority having jurisdiction.
 - b. Temporary support and protection of existing structures shall be provided as required to ensure structural integrity is not compromised.
3. Contractor shall be responsible for costs incurred for temporary support or protection provided by a third-party or authority having jurisdiction to insure safety of the existing utility, Owner, and public and private parties.

B. Existing Buried Utilities:

1. Contractor shall perform field investigate to identify conflicts or interferences between existing utilities and utility Work prior to excavation Work.
 - a. Investigation of conflicts and interferences shall be performed on Site locations, elevations, slopes, etc. of the existing utilities determined during the field investigations.
 - b. Contractor shall notify Engineer and Owner in writing of identified conflicts or interferences. Contractor shall not proceed with the Work until written authorization is provided by the Engineer.
 - c. Identified conflicts and interferences shall be handled in accordance with the Contract Documents. If required, potential modification to the Contract Documents shall be performed in accordance with Section 01 26 00 – Contract Modification Procedures.
2. Contractor shall perform the Work to prevent disruption of existing service and damage to existing utilities.
 - a. Temporary connections shall be provided, as required, to provide un-interrupted service of existing utilities.
 - b. Contractor shall repair damage to existing utilities as directed by the Engineer or the authority having jurisdiction at Contractor's own expense.
 - c. Contractor shall be responsible for damages and repair costs to the authority having jurisdiction if third-party or authority having jurisdiction personnel repair damaged existing utilities.

C. Protection of Existing Structures:

1. Contractor shall sustain existing surface structures in existing place and protect from direct or indirect injury located within or adjacent to the limits of the Work.

Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure or facility.

2. Contractor shall bear all risks attending the presence or proximity of all surface structures within or adjacent to limits of the Work, in accordance with the Contract Documents.
 3. Contractor shall be responsible for damage and expense for direct or indirect injury caused by their Work to structures and facilities.
 4. Contractor shall repair immediately damage caused by their Work, to the satisfaction of owner of damaged structure or facility at no cost to the Owner.
 5. Contractor shall provide temporary weather protection for existing structures and buildings where exterior walls or roofs are modified or disturbed in the Work. Contractor shall be responsible for damages due to inadequate protection of existing structures and building.
- D. Relocation of Surface Structures: Existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, curbs, and fencing, that are temporarily removed to facilitate the Work shall be replaced and restored to their original condition at Contractor's expense.

3.02 PROTECTION OF INSTALLED EQUIPMENT AND MATERIALS

- A. Contractor shall protect installed equipment and materials to prevent damage, injury or loss from subsequent operations. Remove protection facilities when no longer needed prior to completion of the Work.
- B. Control traffic to prevent damage to equipment, materials, and surfaces.
- C. Coverings: Provide coverings to protect materials and equipment from damage.

3.03 PROTECTION DURING INCLEMENT WEATHER

- A. Contractor shall not perform Work during inclement or unsuitable weather that will affect the quality of the completed Work.
- B. Contractor shall take necessary precautions in the event of impending inclement weather to protect equipment, materials and Work from damage or deterioration due to floods, driving rain, wind, or snow storms.
 1. Owner reserves the right to require additional protection measures beyond Contractor's proposed protection measures to protect the Work.

2. Contractor shall not claim additional compensation for additional protection measures required by Owner nor for damages to equipment, material, or Work due to the inclement weather.
- C. When directed by Engineer, Contractor shall stop Work and protect new Work by protective covering during rainstorms for, but not limited to, the following:
1. Concrete mixing and placement.
 2. Paving placement.
 3. Masonry installation.
 4. Buried piping, valve and appurtenance installation.
 5. Additional inclement weather requirements and limitations are specified in individual Specification Sections.

3.04 REPORTING OF ACCIDENTS

- A. Contractor shall immediately report, in writing, to Engineer and Owner accidents out of, or in conjunction with, the performance of Work.
1. Accident reporting includes on Site and adjacent to Site, which cause death, personal injury, or property damage.
 2. Written report shall provide full details and witness statements.
 3. If claim is made against Contractor, Supplier, or Subcontractor due to accident, Contractor shall promptly report facts, in writing, to Engineer and Owner, with full account of the claim.
- B. Contractor shall immediately report death, serious injury, or serious damage caused by telephone or messenger to Engineer and Owner.

3.05 BARRICADES AND WARNING SIGNALS

- A. General:
1. Where the Work is performed on or adjacent to roadway, access road, right-of-way, or public place:
 - a. Provide barricades, fences, lights, warning signs, danger signals, watchmen, and take other precautionary measures for protecting persons, property, and the Work.
 - b. Paint barricades to be visible at night.

- c. From sunset to sunrise, furnish and maintain at least one light at each barricade.
 - d. Erect sufficient barricades to keep vehicles from being driven on or into Work under construction.
 - e. Furnish watchmen in sufficient numbers to protect the Work.
- B. Provide temporary barricades to protect personnel and property for Work not in or adjacent to vehicular travel areas, including indoor work, in accordance with Laws and Regulations.
- C. Contractor's responsibility for maintaining temporary barricades, signs, lights, and for providing watchmen shall continue until the Work is accepted in accordance with the Contract Documents.

END OF SECTION

SECTION 01 73 23
ANCHORAGE AND BRACING OF NONSTRUCTURAL COMPONENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to design and provide anchorage and bracing for all nonstructural components in accordance with the Contract Documents and Building Code requirements, including the seismic design requirements of Chapter 13 in ASCE 7.
- B. This Section covers requirements for only the anchorage and bracing of nonstructural components. Design requirements for nonstructural components (other than their anchorage and bracing) are covered in the Section for that component.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 33 – Special Inspections
- B. Section 05 10 00 – Metal Materials
- C. Section 05 05 23 – Metal Fastening
- D. Further requirements for anchorage and bracing are included in other Sections of the Specifications. See Section for the specific nonstructural component in question.

1.03 DEFINITIONS

- A. Nonstructural components: All architectural, mechanical, electrical, or plumbing elements or systems and their supports or attachments provided under this contract which are permanently attached to new or existing structures.
 - 1. Architectural nonstructural components include, but are not limited to, interior nonstructural walls and partitions, exterior wall panels and glazing elements, glass curtain walls, skylights, cabinets, suspended ceilings, fascia, and cladding.
 - 2. Mechanical nonstructural components include, but are not limited to, HVAC units, fans, water and wastewater treatment process equipment, instrumentation cabinets, piping and ductwork.
 - 3. Electrical nonstructural components include, but are not limited to, conduit systems, cable tray systems, boxes, transformers, panelboards, switchboards, switchgear, busway, individual motor controllers, motor control centers, variable frequency drives, automatic transfer switches, and lighting systems.

4. Plumbing nonstructural components include, but are not limited to, sprinkler systems and associated piping, and sump pumps.
- B. Attachment: Elements including anchor bolts, welded connections, and mechanical fasteners which secure nonstructural components or supports to the structure.
- C. Essential Components: Nonstructural components considered necessary to public safety for which the component importance factor I_p is required by chapter 13 in ASCE 7 to be taken as 1.5, including:
1. Life safety systems which must function following an earthquake, including but not limited to, sprinklers for fire protection, emergency lighting, egress corridors and stairways, and smoke purge systems.
 2. Components which contain, convey or support toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Building Code.
 3. Components which are within or attached to an Occupancy or Risk Category IV structure as defined in ASCE 7 Chapter 1 and are needed for continued operation of the facility or failure could impair the continued operation of the facility.
 4. Components which contain, convey, or support hazardous substances and are attached to a structure or portion thereof classified by the Building Code as a hazardous occupancy.
 5. Process systems and elements designated below:
 - a. Water storage facilities and water pumping systems
 - b. Large diameter piping under high pressure.
 - c. Chemical feed systems and pumps
- D. Nonbuilding Structures: All self-supporting structures which are supported by an independent foundation or by other structures which include, but are not limited to, storage tanks, silos, exhaust stacks, storage racks, and towers.
- E. Delegated Design: Design of a structure or structural element(s) which has been deferred by the contract documents to be performed during the project construction stage, by a registered design professional retained by the Contractor and with the design submitted as a shop drawing to the Engineer.

1.04 REQUIREMENTS

- A. Anchorage and bracing of nonstructural components shall be designed and installed to resist the controlling load combination of gravity loads, operational forces (including static and dynamic), wind forces, seismic forces and any other applicable forces required in accordance with the governing Building Code.

- B. Anchorage and bracing of nonstructural components shall comply with seismic design requirements of ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt. The following nonstructural components are exempt from requirements specific to seismic anchorage and bracing: (See paragraph 1.07.F.3 herein for Seismic Design Category)
1. Storage cabinets no more than 6 feet tall, furniture, and movable equipment, regardless of Seismic Design Category.
 2. All architectural, mechanical, electrical, and plumbing nonstructural components in Seismic Design Category A.
 3. All mechanical, electrical, and plumbing nonstructural components in Seismic Design Category B.
 4. Architectural nonstructural components in Seismic Design Category B, other than parapets, provided that $I_p = 1.0$.
 5. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category C provided that either:
 - a. $I_p = 1.0$, and the component is positively attached to the structure, or
 - b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.
 6. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category D, E or F that are positively attached to the structure, provided that either:
 - a. $I_p = 1.0$, component weighs 400 lbs or less and its center of mass is 4 ft or less above a floor level, and flexible connections are provided between the components and associated ductwork, piping and conduit: or
 - b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.
 7. Other exemptions as allowed by the Specifications, Codes and Standards referenced herein.

1.05 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. The Building Code shall be the version in effect at the time of Bid within the jurisdiction where the Work is located. All other referenced specifications, codes, and standards refer to the version as referenced by the Building Code. If no version is referenced by the Building Code, then the most current issue available at the time of Bid shall be used.
1. 2021 International Building Code

2. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
3. NFPA 13 Standard for Installation of Sprinkler Systems
4. FEMA 412 Installing Seismic Restraints for Mechanical Equipment
5. FEMA 413 Installing Seismic Restraints for Electrical Equipment
6. FEMA 414 Installing Seismic Restraints for Duct and Pipe
7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Seismic Restraint Manual: Guidelines for Mechanical Systems
8. ACI 318 Building Code Requirements for Structural Concrete and Commentary
9. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete
10. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

1.06 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 1. Anchorage and bracing submittals for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems that do not have a design for anchorage and bracing provided within the Contract Documents. Submittals shall include the following:
 - a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment, and edge distance requirements to satisfy operational, wind, seismic and other forces required by the governing Building Code. Details shall also indicate grout, bearing pads, isolators, etc. required for complete installation.
 - b. Design calculations, signed and sealed by a Professional Engineer registered in the State or Commonwealth in which the project is located. Design shall include all loads and load combinations required by the governing Building Code. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.
 - c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State or Commonwealth in which the project is located, showing specific details of the support design including material, installation, attachments, connection hardware, etc., and the layout and location of all hangers and supports (resisting both gravity and lateral loads), including bracing orientation and direction of force(s) to be resisted.

- d. Seismic loads and requirements are not required to be included in design for anchorage and bracing of components which are exempt in accordance with Section 1.04B.
- e. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.1.f below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.
- f. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.

1.07 DESIGN REQUIREMENTS

- A. Mechanical fasteners used to secure nonstructural components shall meet the requirements of Section 05 05 23 – Metal Fastening. Post-installed concrete anchors shall be prequalified for use in seismic applications.
- B. No reaction loads (either vertical or lateral) from nonstructural component anchorage and bracing shall be allowed on any element where design has been delegated unless the additional loads on the element have been coordinated with the delegated designer and the submittal is accompanied by a sealed letter from the delegated designer indicating the element has been designed to support the reaction loads.
- C. Reaction loads from nonstructural component anchorage and bracing shall be transferred directly to the primary structural members (girders, beams, etc.), with no components supported from secondary members (purlins, bracing, etc.) unless otherwise approved.
- D. No holes shall be drilled into any structural steel for attachment of component supports without prior approval of the Engineer.
- E. Attachments of nonstructural component anchorage and bracing that cause overstressing of any structural element shall not be permitted.
- F. Seismic Requirements
 - 1. Seismic anchorage and bracing for nonstructural components shall be subject to the current local Building Code in conjunction with the seismic provisions of the International Building Code (IBC) Section 1613 and referenced ASCE 7 Chapter 13.
 - 2. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight (as defined by ASCE 7) of the structure it is attached to, the component shall be classified as a nonbuilding structure for purposes of seismic design. Seismic design for nonbuilding structures shall comply with Building Code requirements in conjunction with the provisions of ASCE 7 Chapter 15.

3. Nonstructural components shall be assigned to the same Seismic Design Category as the structure they occupy or to which they are attached. Design of seismic support system and anchorage shall incorporate the site-specific seismic criteria given on the Contract Drawings. Criteria shall include site-specific spectral response coefficients, Site Class, Seismic Design Category, and Risk Category.
 4. Component Importance Factor I_p shall be 1.5 for all essential nonstructural components noted in item 1.03.E above. All other nonstructural components shall utilize $I_p = 1.0$ unless noted otherwise.
 5. Components shall be anchored and braced for earthquake forces both in the vertical and each orthogonal direction. Seismic anchorage and bracing shall limit deflections of components per ASCE 7, and the displacements shall not impede component functionally and containment.
 6. Anchorage design shall account for disparate seismic response behavior of supporting structures. Seismic supports or bracing shall not cross structural expansion joints. Nonstructural components shall not be attached to multiple structural elements which may respond differently during a seismic event without provisions to accommodate independent movement. Flexible expansion loops or offsets, flexible joints, bellows type pipe expansion joints, couplings, etc. shall be provided at structure expansion joints to allow for independent structure movement and thermal movement of piping, ductwork, and conduit. Minimum movement capability in the vertical and each orthogonal direction shall equal the width of the joint.
 7. Provide flexible connections, piping, conduit, etc. at foundation levels where below grade utilities enter the structure.
 8. Design of support system for components with multiple attachments shall consider the stiffness and ductility of the supporting members. Equipment designed as free-standing shall only be attached at its base. Use of non-free-standing equipment requiring both vertical and lateral attachment is contingent upon loads applied to the structure and requires approval by the Engineer.
 9. The seismic anchorage and bracing design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from the specifications or the approved equipment manufacturer. The equipment manufacturer shall verify the attachment points on the equipment can safely withstand the combination of seismic, self-weight and other loads imposed.
- G. Powder actuated fasteners in steel or concrete shall not be used for sustained tension loads in Seismic Design Categories D, E or F unless approved for seismic loading or specifically exempted by ASCE 7. Powder actuated fasteners in masonry shall not be used unless approved for seismic loading regardless of Seismic Design Category.
- H. Friction clips shall not be used in Seismic Design Categories D, E or F for supporting sustained tension loads in combination with resisting seismic forces. C-type and large

flange clamps may be used for hanger attachments provided restraining straps meeting NFPA 13 requirements are utilized and loosening of threaded connections is prevented by lock nuts, burred threads, etc.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Anchorage and bracing of nonstructural components shall be constructed of appropriate materials and connecting hardware to provide a continuous load path between the component and supporting structure of sufficient strength and stiffness to resist the calculated design seismic forces and displacements.
- B. Component anchorage, bracing and connection materials shall be compatible with and in general match the component and component gravity support materials. Contact between dissimilar metals shall be prevented.

PART 3 – EXECUTION

3.01 INSTALLATION OF ANCHORAGE AND BRACING

- A. No anchorage and bracing of nonstructural components shall be installed prior to review and acceptance by the Engineer and permitting agency.
- B. Equipment shall be installed per the manufacturer's recommendations. Fasteners shall meet manufacturer's requirements.
- C. Following installation, all anchorage and bracing and seismically qualified equipment shall be inspected. See Section 01 45 33 – Special Inspections for requirements.

END OF SECTION

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SECTION 01 75 00
CHECKOUT AND STARTUP PROCEDURES

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Checkout of products and equipment.
 - 2. Startup procedures of products and equipment
- B. Contractor shall initially start up and place equipment installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
- C. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
- D. Provide chemicals, lubricants, and other required operating fluids.
- E. General activities include:
 - 1. Cleaning, as required under other provisions of the Contract Documents.
 - 2. Removing temporary protective coatings.
 - 3. Checking and correcting (if necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
 - 4. All adjustments required.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Definitions:
 - 1. Displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in distance per time, velocity and acceleration of the vibration cycle. Displacement, velocity and acceleration shall be measured by instruments/equipment equal to IRD Mechanalysis, Bentley, Nevada.
- B. Coordination:

1. Coordinate checkout and start-up with other contractors performing Work at the Site.
2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
3. Responsibility for proper operation is by Contractor.
4. Supplier shall be present during checkout, start-up, and initial operation, except as otherwise specified.
5. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by Contractor, in accordance with Section 01 78 23 – Operations and Maintenance Data.

C. Contractor's Requirements Prior to Owner's Responsibility:

1. Owner will assume responsibility for the equipment upon Substantial Completion.
2. Prior to turning over to Owner responsibility for operating and maintaining system or equipment shall be in accordance with this Section and the following requirements:
 - a. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23 – Operations and Maintenance Data.
 - b. Complete system field quality control testing in accordance with the Contract Documents including, but not limited to, the following:
 - 1) Start-up certification shall be performed and completed by the equipment Supplier for the equipment and material prior to be placed into intended use by Owner as specified in the Contract Documents.
 - 2) Equipment and material shall be operated for a minimum 30-day operational period to verify performance. In addition to specific requirements specified in the individual specification sections, process data that is recorded in the PLC shall be submitted to the Engineer in tabular format showing hourly process performance data. A log of all alarms shall also be submitted, along with notes describing corrective measures applied in response to alarm condition.
 - 3) If equipment and material does not perform satisfactorily during the 30-day operational period, then the warranty period start shall be delayed until satisfactorily performance is verified.

- a) Contractor shall repair or replace equipment and material that does not perform satisfactorily at no cost to Owner.
- b) Contractor shall furnish all equipment and material, labor, and incidentals necessary to provide equipment and material to the performance level required by the Contract Documents.
- c. Obtain from Engineer final certificate of Substantial Completion for either entire Work or the portion being turned over to Owner.

1.03 SUBMITTALS

- A. Startup Schedule: Detailed summary of schedule, duration, manpower requirement, and Contractor's means and methods for startup.
- B. Vibration testing results
- C. Closeout Submittals: Manufacturer's certification of installation in accordance with this Section.
- D. Startup testing and operational demonstration performance data.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PRELIMINARY REQUIREMENTS

- A. Prior to the start-up of the facilities, Contractor shall have prepared and tested all equipment, subsystems and systems in accordance with the requirements of the individual Specification Section to check its ability for sustained operation, including inspections and adjustments by Manufacturer's representative.
- B. Contractor shall develop and submit schedule in accordance with this Section.
- C. After the facilities are sufficiently complete to permit start-up, Contractor shall furnish competent personnel to start-up the facilities. Contractor will be responsible for startup of all facilities constructed under this Contract. During the initial start-up period the Contractor shall check and provide for mechanical operation in accordance with the Contract Documents.

3.02 FIELD QUALITY CONTROL

- A. Manufacturers' Field Services:

1. When specified, furnish services of factory trained representatives of material and equipment manufacturers as specified, including supervising installation, adjusting, checkout, start-up, and testing of materials and equipment.
2. Certification:
 - a. When services by manufacturer are required at the Site, within 14 days after first test operation of equipment, submit to Engineer a letter from manufacturer, on manufacturer's letterhead, stating that materials and equipment are installed in accordance with manufacturer's requirements and installation instructions, and in accordance with the Contract Documents.
 - b. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.
3. Manufacturer shall bring any discrepancies to the immediate attention of the Contractor for correction. Contractor shall promptly correct any discrepancies noted by the Manufacturer. Manufacturer shall coordinate correction of discrepancies with the Contractor. Discrepancies and their correction shall be noted in inspection records and in all required reports. Any corrections that result in changes to the work as shown on the Contract Documents shall be approved by the Engineer prior to their execution.

3.03 SYSTEM START-UP

- A. Equipment and materials shall be provided in conformance with the manufacturer's installation instructions and in accordance with the Contract Documents.
- B. Provide start-up services as specified in the individual Specification Sections.
- C. Contractor shall furnish consumables required for startup including, but not limited to, electricity, water, chemicals and lubrication. Contractor shall provide a plan for disposal of water used for testing unless otherwise specified in the Contract Documents.
- D. General system requirements:
 1. Start-up of the plant by Contractor shall include all mechanical systems, including but not limited to, pumps, compressors, and like equipment, and the ventilating, air conditioning (or heating), plumbing, and electrical systems. Start-up of either the heating or air conditioning systems is dependent upon the time of year that the plant start up is initiated. Contractor will be required to return at the beginning of the next heating or air conditioning season (whichever is applicable) to start the appropriate system.
 2. Cleaning as required under provisions of the Contract Documents.

3. Remove temporary protective coatings.
4. Flushing and replacing greases and lubricants as required by Manufacturer
5. Lubrication.
6. Verify the following:
 - a. Shaft and coupling alignments and reset where needed.
 - b. Set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
 - c. Leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping, conduits and ducts that may apply stress on equipment.
7. Valves:
 - a. Tighten packing glands to ensure no leakage but allow valve stems to operate without galling.
 - b. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 - c. Replace packing on valves that continue to leak.
 - d. Remove and repair bonnets that leak.
 - e. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".
8. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.
9. Tighten flanges and other pipe joints after system has been placed in operation.
10. Replace gaskets that show signs of leakage after tightening.
11. Inspect all joints for leakage:
 - a. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 - b. Clean threads on both parts and apply compound and remake joints.
12. After system has been placed in operation, clean valve seats and headers in fluid system to ensure freedom from foreign matter.

13. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.
14. Repair damaged insulation.

END OF SECTION

SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Substantial Completion.
 - 2. Final inspection.
 - 3. Request for final payment.

1.02 REFERENCES

- A. Definitions:
 - 1. Substantial completion procedures for requesting and documenting are in the General Conditions, as modified by Supplemental Conditions.
 - 2. Final inspection procedures for requesting and documenting are in the General Conditions, as modified by Supplemental Conditions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Request for Final Payment:
 - 1. Procedure: Submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions.
- B. Request for final payment shall include:
 - 1. Documents required for progress payments in Section 01 29 76 – Progress Payment Procedures.
 - 2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
 - 3. Releases or Waivers of Lien Rights:
 - a. Provide a final release or waiver by Contractor and each Subcontractor and Supplier that provided Contractor with labor, material, or equipment totaling \$10,000 or more.

- b. Provide list of Subcontractors and Suppliers for which release or waiver of Lien is required.
 - c. Each release or waiver of Lien shall be signed by an authorized representative of the entity submitting release or waiver to Contractor, and shall include Subcontractor's or Supplier's corporate seal, when applicable.
 - d. Release or waiver of Lien may be conditional upon receipt of final payment.
 - e. Manufacturer's Affidavit of Release of Liens – furnish a separate, completed form from the manufacturer.
4. Consent of Surety Company to Final Payment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Requirements for operation and maintenance data, manuals, and documentation.
1. Submit operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, as instructional and reference manuals by operations and maintenance personnel at the Site.
 2. Required operation and maintenance data groupings are listed in this Section. At minimum, submit operation and maintenance data for:
 - a. All equipment and systems
 - b. Valves, gates, actuators, and related accessories
 - c. Instrumentation and control devices
 - d. Electrical gear
 3. For each operation and maintenance manual, submit the following:
 - a. Preliminary Submittal: Printed and bound copy of entire operation and maintenance manual or electronic copy, except for test data and service reports by Supplier.
 - b. Final Submittal: Printed and bound copy of complete operations and maintenance manual and electronic copy, including test data and service reports by Supplier.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Quantity Required and Timing of Submittals:
1. Preliminary Submittal:
 - a. Printed Copies: One copy, exclusive of copies required by Contractor.
 - b. Electronic Copies: One copy.
 - c. Submit to Engineer, whichever occurs first:

- 1) 60 days prior to starting training of operations and maintenance personnel.
 - 2) 30 days prior to field quality control testing at the Site.
 - 3) 30 days prior to unloading equipment and material at the Site.
- d. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by Engineer, before associated materials and equipment will be eligible for payment.
2. Preliminary Submittal shall be reviewed by Engineer. One printed or electronic copy shall be returned to Contractor with required revisions noted.
3. Final Submittal: Provide 14 days prior to checkout and startup procedures specified in Section 01 75 00 – Checkout and Startup Procedures, unless Submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: Two copies.
 - b. Electronic Copies: One copy.

B. Format of Printed Copies:

1. Binding and Cover:
 - a. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
 - b. Provide the following information on cover of each volume:
 - 1) Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - 2) Name or type of material or equipment covered in the manual.
 - 3) Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - 4) Name of Project and, if applicable, Contract name and number.
 - 5) Name of building or structure, as applicable.
 - c. Provide the following information on spine of each volume:
 - 1) Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".

- 2) Name or type of material or equipment covered in the manual.
- 3) Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
- 4) Project name and building or structure name.

2. Drawings:

- a. Bind into the manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing.
- b. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include no more than three drawing sheets per pocket.

3. Copy Quality and Document Clarity:

- a. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color.
- b. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content.

4. Organization:

- a. Provide table of contents in each volume for each chapter or section.
- b. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

C. Format of Electronic Copies:

1. Each electronic copy shall include all information included in the corresponding printed copy.
2. Submit electronic copy via transferable method and format acceptable to Engineer.
3. File Format:
 - a. Acceptable formats include Adobe PDF, Microsoft Word, Autodesk DWF, and AutoCAD.

- b. Files shall be electronically searchable.
 - c. Submit separate file for each separate document in the printed copy.
 - d. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the corresponding printed copy document's table of contents
 - 2) Each figure
 - 3) Each table
 - 4) Each appendix
4. Submit drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", ".gif", ".dwf", or ".dwg".

D. General Content Requirements:

- 1. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings as applicable, bills of materials, technical bulletins, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.
- 2. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- 3. Submit written explanations of all safety considerations relating to operation and maintenance procedures.
- 4. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
 - a. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include

- pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
- b. Recommended schedule for each preventive maintenance task.
 - c. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 - d. Table of alternative lubricants.
 - e. Troubleshooting instructions.
 - f. List of required maintenance tools and equipment.
5. Submit complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
- a. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 - b. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 - c. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 - d. For each part or piece include the following information:
 - 1) Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - 2) Part name or description.
 - 3) Manufacturer's part number.
 - 4) Quantity of each part used in each assembly.
 - 5) Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
6. Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number).
7. Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or

equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.

8. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
9. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
10. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
11. Submit copy of warranty bond and service contract as applicable.
12. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

1.03 SUBMITTALS

- A. Action/Informational Submittals: Submit preliminary schedule (listing) of operations and maintenance data for Engineer's review. Preliminary operations and maintenance data shall be grouped as major equipment and material systems and divided into sub-systems as required for clarity, subject to Engineer's approval.
- B. Closeout Submittals:
 1. Operation and maintenance data: Submit the operations and maintenance data indicated in the Contract Documents, grouped into submittals as approved by Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements for recording changes to record documents.
 - 2. Requirements for electronic files furnished by Engineer.
- B. Contractor shall maintain and submit to Engineer with record documents in accordance with the Specifications, General Conditions, and Supplementary Conditions.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Maintenance of Record Documents:
 - 1. The following record documents shall be maintained in the Contractor's field office:
 - a. Drawings, Specifications, and Addenda.
 - b. Shop Drawings, Samples, and other Contractor submittals, including records of test results, approved or accepted as applicable, by Engineer.
 - c. Change Orders, Work Change Directives, Field Orders, photographic documentation, survey data, and all other documents pertinent to the Work.
 - 2. Update record documents on a monthly basis, minimum.
 - 3. Provide files and racks for proper storage and easy access to record documents.
 - 4. Make record documents available for inspection upon request of Engineer or Owner.
 - 5. Do not use record documents for purpose other than serving as Project record. Do not remove record documents from Contractor's field office without Engineer's approval.
- B. Submittal of Record Documents:
 - 1. Submit to Engineer the following record documents: Drawings.

2. Prior to readiness for final payment, submit to Engineer one copy of final record documents. Submit complete record documents; do not make partial submittals.
3. Submit record documents with transmittal letter on contractor letterhead complying with letter of transmittal requirements in Section 01 33 00 – Submittal Procedures.
4. Record documents submittal shall include certification, with original signature of official authorized to execute legal agreements on behalf of Contractor.

C. Electronic Files Furnished by Engineer:

1. CADD files will be furnished by Engineer upon the following conditions:
 - a. Contractor shall submit to Engineer a letter on Contractor letterhead requesting CADD files and providing specific definition(s) or description(s) of how files will be used, and specific description of benefits to Owner (including credit proposal, if applicable) if the request is granted.
 - b. Contractor shall execute Engineer's standard agreement for release of electronic files and shall abide by all provisions of the agreement for release of electronic files.
 - c. Layering system incorporated in CADD files shall be maintained as transmitted by Engineer. CADD files transmitted by Engineer containing cross-referenced files shall not be bound by Contractor. Drawing cross-references and paths shall be maintained. If Contractor alters layers or cross-reference files, Contractor shall restore all layers and cross-references prior to submitting record documents to Engineer.
 - d. Contractor shall submit record drawings to Engineer in same CADD format that files were furnished to Contractor.

1.03 SUBMITTALS

- A. Closeout Submittals: Provide record documentation as specified in this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.

- B. Keep record documents current. Make entries on record documents within two working days of receipt of information required to record the change.
- C. Do not permanently conceal the Work until required information has been recorded.
- D. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Engineer-accepted record documents.
- E. Marking of Entries:
 - 1. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.
 - 2. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files.
 - 3. Date all entries on record documents.
 - 4. Call attention to changes by drawing a “cloud” around the change(s) indicated.
 - 5. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

3.02 RECORDING CHANGES TO DRAWINGS:

- A. Record changes on copy of the Drawings. Submittal of Contractor-originated or -produced drawings as a substitute for recording changes on the Drawings is unacceptable.
- B. Record changes on plans, sections, schematics, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.
- C. Record actual construction including:
 - 1. Depths of various elements of foundation relative to Project datum.
 - 2. Field changes of dimensions, arrangements, and details.
 - 3. Changes made in accordance with Change Orders, Work Change Directives, and Field Orders.
 - 4. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document changes.

3.03 RECORDING CHANGES FOR SCHEMATIC LAYOUTS:

- A. In some cases, on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Contractor subject to acceptance by Engineer.
- B. Record on record documents all revisions to schematics on Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Contract. Record actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
- C. When dimensioned plans and dimensioned sections on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items
 - 1. Clearly identify the Work item by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.
 - 2. Show by symbol or note the vertical location of Work item; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping not embedded, also provide elevation dimension relative to Project datum.
 - 3. Descriptions shall be sufficiently detailed to be related to Specifications.
- D. Engineer may furnish written waiver of requirements relative to schematic layouts shown on plans and sections when, in Engineer’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on waiver(s) being issued.

3.04 REQUIREMENTS FOR SUPPLEMENTAL DRAWINGS:

- A. In some cases, drawings produced during construction by Engineer or Contractor supplement the Drawings and shall be included with record documents submitted by Contractor. Supplemental record drawings shall include drawings provided with Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings due to space limitations.
- B. Supplemental drawings provided with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.

- C. When supplemental drawings developed by Contractor using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings in AutoCAD (latest version) as part of record drawing submittal.

3.05 RECORDING CHANGES TO SPECIFICATIONS AND ADDENDA:

- A. Mark each Section to record:
 - 1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually provided.
 - 2. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

END OF SECTION

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SECTION 01 88 16
WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. All concrete work and sealing work around built-in items and penetrations shall be performed as required to ensure that groundwater, surface water, and water or liquids in tanks, channels, and containers will not intrude into any equipment rooms, pipe galleries, habitable areas, or other generally dry areas.
- B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.
- C. Each unit shall be tested separately, and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source.
- D. All water holding structures shall be tested for leakage by the Contractor. The Contractor shall provide at their own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 45 23 – Testing Services Furnished by Contractor
- B. Section 03 30 00 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ACI 350.1-10 - Specification for Tightness Testing of Environmental Engineering Concrete Structures

1.04 SUBMITTALS

- A. Testing procedures shall be submitted for approval prior to the test.
- B. Testing Report: Prior to placing the structure in service, submit for review and approval a detailed bound report summarizing the watertightness test data, describing the testing procedure, and showing the calculations confirming the test data.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 TEST PREPARATION

- A. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic tightness testing without approval of the Engineer.
- B. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.
- C. Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies (pinholes, tears, and partially fused splices) and must pass integrity testing. Deficiencies shall be repaired.
- D. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water in or outside of the structure that would interfere with the inspection of the exposed concrete surfaces of the structure shall be removed.
- E. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired before filling the containment structure with water.
- F. All openings, fittings, and pipe penetrations in the structure shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing. All structural penetrations and inlet/outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the watertightness of these appurtenances. If the structure will be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving through this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage.
- G. The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing.
- H. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.

- I. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

3.02 PROCEDURE

- A. The initial filling of a new structure should not exceed a rate of 4 ft/hour. Filling shall be continued until the water surface is at the design maximum liquid level, or either 1 in. below any fixed overflow level in covered containment structures or 4 in. in open structures, whichever is lower.
- B. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.
- C. Watertightness Test - Part 1: Qualitative Criteria
 1. The water shall be kept at the test level for at least 3 days prior to Part 2 of the testing.
 2. The exterior surfaces of the structure shall be observed in both the early mornings and later afternoons during the 3-day period before Part 2 of the test. If any water is observed on the structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where water droplets can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.
 3. Wet areas on top of wall footing shall not indicate a failure of Part 1 of the test unless the water can be observed to be flowing.
 4. Part 2 of the test may begin prior to completion of repairs for Part 1. However, all defects causing the failure of Part 1 shall be repaired before the structure is accepted. The 3-day period of keeping water at the test level shall be observed again after completion of all repairs and prior to acceptance of structure.
- D. Watertightness Test - Part 2: Quantitative Criteria
 1. The test measurements shall not be scheduled when the weather forecast predicts a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface could be frozen before the test is completed.
 2. The vertical distance to the water surface shall be measured to within 1/16 in. from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals. Measurements taken at the same time of day will reduce the probability of temperature difference.

3. Measurements shall be taken at two locations, 180° apart, to minimize the possible effect of differential settlement. Measurements shall be taken at the same locations to reduce the probability of measurement differences.
4. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.
5. The water temperature shall be recorded at a depth of 18 in. below the water surface at the start and end of the test.
6. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals. Determination of evaporation by a shallow pan-type measuring device is not acceptable due to possible heating of the bottom of the shallow pan resulting in accelerated evaporation.

3.03 EVALUATION

- A. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the test during Part 2.
- B. At the end of the test period, the water surface shall be recorded to within 1/16-in at the location of original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.
- C. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.
- D. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test.
- E. During Part 2 of the test, observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. Excessive wetness resulting in water droplets on dry hand after contact will also be considered a failed test. Slight dampness with only slight wetting of dry hand will not necessarily qualify as a failed test, depending on application, location, and visibility. Dampness or wetness on top of a footing shall not be considered as a failed test.

3.04 RETESTING

- A. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.
- B. The Contractor shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the

option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.

- C. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.
- D. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed. A minimum of three days shall occur between completion of any repairs with water level remaining at required test level without further issues prior to structure being deemed as satisfying all requirements of testing.

3.05 NOTIFICATION BY ENGINEER

- A. If any leaks greater than the specified amount are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

END OF SECTION

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SECTION 03 11 00
CONCRETE FORMWORK

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 15 00 – Concrete Accessories
- B. Section 03 15 16 – Joints in Concrete
- C. Section 03 21 00 – Reinforcing Steel
- D. Section 03 30 00 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. 2021 International Building Code/ACI 318 – Building Code Requirements for Structural Concrete
 - 2. ACI 301 – Specifications for Structural Concrete
 - 3. ACI 347 – Recommended Practice for Concrete Formwork
 - 4. U.S. Product Standard for Concrete Forms, Class I, PS 1
 - 5. ACI 117 – Specification for Tolerances for Concrete Construction and Materials and Commentary

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Manufacturer's data on proposed form release agent

2. Manufacturer's data on proposed formwork system including form ties

1.05 QUALITY ASSURANCE

- A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 – PRODUCTS

2.01 FORMS AND FALSEWORK

- A. All forms shall be smooth surface forms unless otherwise specified.
- B. Wood materials for concrete forms and falsework shall conform to the following requirements:
 1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.
 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.
- C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Sika Corporation or approved equal. Friction fit plugs shall not be used.

- C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

PART 3 – EXECUTION

3.01 FORM DESIGN

- A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.
- B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

- A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.
- B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.
- C. Forms shall be true to line and grade and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.

- D. Forms shall be mortar tight to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form.
- E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.
- G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.
- H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.
- I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.
- J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts

shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

- K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

- A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.
- B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.
- C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and benchmarks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- D. Regardless of the tolerances specified, no portion of the structure shall extend beyond the legal boundary of the structure.

3.04 FORM ACCESSORIES

- A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.
- B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03 35 00 – Concrete Finishes. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending

through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION – FORM RELEASE AGENT

- A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

- A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

- A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

- A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.
- B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

Ambient Temperature (°F.) During Concrete Placement

	Over 95°	70°-95°	60°-70°	50°-60°	Below 50°
Edge Forms for Slabs on Grade	1 day	1 day	1 day	1 day	
Walls	5 days	2 days	2 days	3 days	Do not remove until directed by Engineer (7 days minimum)
Columns	7 days	2 days	3 days	4 days	
Beam Soffits	10 days	7 days	7 days	7 days	
Elevated Slabs	12 days	7 days	7 days	7 days	

- C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.
- D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall always be available for inspection at the site, and two copies shall be furnished to the Engineer upon completion of the concrete work.

3.09 RESHORING

- A. When reshoring is permitted or required the operations shall be planned and subjected to approval by the Engineer.
- B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.
- C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.
- D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and, in all cases, shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.

- E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

END OF SECTION

SECTION 03 15 00
CONCRETE ACCESSORIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, crack inducing joint inserts, epoxy bonding agent, and neoprene bearing pads.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 15 16 – Joints in Concrete
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 07 90 00 – Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 2. ASTM D412 – Standard Tests for Rubber Properties in Tension
 - 3. ASTM D 624 – Standard Test method for Rubber Property - Tear Resistance
 - 4. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics
 - 5. ASTM D1751 – Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types)
 - 6. ASTM D 1752 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
 - 7. ASTM D 1171 – Standard Test Method for Ozone Resistance at 500 pphm
 - 8. ASTM D 471 – Standard Test Method for Rubber Properties

9. ASTM D 2240 – Standard Test for Rubber Property – Durometer Hardness

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 1. Manufacturer's literature on all products specified herein including material certifications.
 2. Proposed system for supporting PVC waterstops in position during concrete placement.
 3. Samples of products if requested by the Engineer.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

- A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.
- B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.
- C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.
- D. The required minimum physical characteristics for this material are:
 1. Tensile strength – 1,750 psi (ASTM D-638).
 2. Ultimate elongation – not less than 280% (ASTM D-638).
- E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.
- F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.
- G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.02 HYDROPHILIC WATERSTOPS

- A. Hydrophilic waterstops shall be designed to expand under hydrostatic conditions. For hydrostatic head pressure greater than 25 feet, waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak. For hydrostatic head pressure 25 feet or less, Adeka Ultra Seal KBA-1510FP or Hydrotite CJ-1020-2K shall be used. Concrete cover and confinement requirements shall be in accordance with the manufacturer's recommendations.
- B. Waterstops shall be fabricated from a chemically modified natural rubber product with a hydrophilic agent. Use of bentonite based waterstop material will not be allowed.
- C. Waterstops shall either contain an interior stainless-steel mesh or an interior coextrusion of non-hydrophilic rubber to ensure expansion occurs along the width and thickness of the waterstop thereby restricting the expansion in the longitudinal direction.

2.03 WATERSTOP ADHESIVE

- A. Adhesive between waterstops and existing concrete shall be Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond hydrophilic waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-Z by Sika Greenstreak, or approved equal.

2.04 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07 90 00 – Joint Fillers, Sealants, and Caulking.

PART 3 – EXECUTION

3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS

- A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.
- B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.

- C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.
- D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.
- E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.
- F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:
 - 1. Tensile strength less than 80 percent of parent material.
 - 2. Overlapped (not spliced) Waterstop.
 - 3. Misalignment of waterstop geometry at any point greater than 1/16 inch.
 - 4. Visible porosity or charred or burnt material in weld area.
 - 5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

3.02 WATERSTOP ADHESIVE

- A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.
- B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.03 BEARING PADS

- A. Care shall be taken in fabricating pads and related metal parts so effects detrimental to the proper performance of the pads, such as uneven bearing and excessive bulging, will not occur.

END OF SECTION

SECTION 03 15 16
JOINTS IN CONCRETE

PART 1 – GENERAL

1.01 THE REQUIREMENTS

- A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.
- B. Types of joints in concrete shall be defined as follows:
 - 1. Construction Joints – Intentionally created formed joints between adjacent concrete placements with 100% of reinforcement continuous through joint.
 - 2. Expansion Joints – Formed joints in concrete which separate adjacent sections to allow movement due to dimensional increases and reduction of adjacent sections (temperature and shrinkage). Reinforcement terminates within concrete on each side of joint. Expansion joints may also be considered isolation joints.
 - 3. Contraction Joints – Formed joints in concrete to create interface between concrete placements to allow movement due to dimensional reduction of adjacent sections (shrinkage).
 - a. Full Contraction Joints – Formed contraction joints with no bonded reinforcement passing through the joint.
 - b. Partial Contraction Joints – Formed contraction joints with no more than 50% of bonded reinforcement passing through the joint.
 - 4. Crack Inducing Joints – Joints formed, tooled, or sawcut in a monolithic placement to create a weakened plane to regulate the location of crack formation due to dimensional reduction of adjacent sections (shrinkage).

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 15 00 – Concrete Accessories
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 07 90 00 – Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
1. ACI 301 – Specifications for Structural Concrete for Buildings
 2. ACI 318 – Building Code Requirements for Structural Concrete
 3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
 4. ACI 224.3 – Joints in Concrete Construction

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
1. Layout drawings showing location and type of all joints to be placed in each structure.
 2. Details of proposed joints in each structure.
 3. For sawcut crack-inducing joints, submit documentation indicating the following:
 - a. Proposed method of sawcutting indicating early entry or conventional sawing.
 - b. Description of how work is to be performed including equipment to be utilized, size of crew performing the work and curing methods.
 - c. Description of alternate method in case of time constraint issues or failure of equipment.

PART 2 – MATERIALS

2.01 MATERIALS

- A. All materials required for joint construction shall comply with Section 03 15 00 - Concrete Accessories and Section 07 90 00 – Joint Fillers, Sealants and Caulking.

PART 3 – EXECUTION

3.01 CONSTRUCTION JOINTS

- A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and proposed location to Engineer for approval. All joints shall be construction joints or expansion joints unless otherwise specified on the Drawings or approved by the Engineer on the joint plan submittal.
- B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- C. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.
- D. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer.
- E. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.
- F. .

3.02 EXPANSION JOINTS

- A. Size and location of expansion joints shall be as shown on the Drawings. All joints shall be construction joints or expansion joints unless otherwise specified on the Drawings or approved by the Engineer on the joint plan submittal.
- B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03 15 00 – Concrete Accessories.

3.03 CONTRACTION JOINTS

- A. Contraction joints shall be located as shown on the Drawings or otherwise approved by the Engineer on the joint plan submittal. Contractor shall submit proposed locations and details of all contraction joints concurrent or prior to submission of reinforcement drawings. Use of contraction joints at locations not specifically detailed on the Drawings requires Engineer approval and will only be considered if meeting the stipulations herein.

- B. Full contraction joints may be considered where the structural behavior of the element allows termination of all reinforcement through joint without compromise of structural integrity of element.
- C. Partial contraction joints may be considered where the structural behavior of the element requires partial continuation of reinforcement through joint to ensure structural integrity.
- D. Where full contraction joints are allowed, maximum distance between horizontal contraction joints in slab and vertical contraction joints in walls shall be 50'-0". For exposed walls with fluid or earth on the opposite side, spacing between vertical and horizontal contraction joints shall be a maximum of 25'-0".
- E. Bond breaker shall be provided between sections for all contraction joints.
- F. Joint plan of walls and slabs shall consider aspect ratio to create placement of sections as close to square as possible. Aspect ratio is defined as the ratio of plan dimensions for slab sections and length to height placement of wall sections. Aspect ratios shall be between 0.65 and 1.5.

3.04 CRACK INDUCING JOINTS

- A. Location of crack inducing joints shall be as shown on the Drawings or submitted by Contractor and approved by Engineer.
- B. Crack inducing joints shall be formed either by saw cutting, tooling, or use of approved inserts as specified in Section 03 15 00 – Concrete Accessories.
- C. If approved by the Engineer, saw cutting of contraction joints in lieu of forming or tooling shall conform to the following requirements:
 - 1. Joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.
 - 2. Curing shall be performed using wet curing methods as indicated in Section 03 39 00 – Concrete Curing. Curing mats, fabrics or sheeting materials shall remain in place to the extent possible while cutting of joint is being performed. Curing materials shall only be removed as required and shall be immediately reinstalled once cutting of the joint has been completed.
 - 3. Depth of joint shall be as shown on the drawings or noted in these specifications. At locations where the joint cannot be installed to full depth due to curbs or other stopping points hand tools shall be used to complete joints.
 - 4. Saw cut joints shall meet the requirements of ACI 224.3, Section 2.8, Jointing Practice.

- D. Unless noted otherwise on Drawings, depth of crack inducing joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.05 JOINT PREPARATION

- A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.
- C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.
- D. All joints shall be sealed as shown on the Drawings and specified in Section 03 15 00 – Concrete Accessories.

END OF SECTION

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SECTION 03 21 00
REINFORCING STEEL

PART 1 – GENERAL

1.01 THE REQUIREMENTS

- A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.
- B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 15 00 – Concrete Accessories
- C. Section 03 30 00 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. Building Code for the State or Commonwealth in which the project is located.
 - 2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice
 - 3. ACI MNL-66 - ACI Detailing Manual
 - 4. ACI 315 - Details and Detailing of Concrete Reinforcing
 - 5. ACI 318 - Building Code Requirements for Structural Concrete
 - 6. WRI - Manual of Standard Practice for Welded Wire Fabric
 - 7. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 8. ASTM A706 – Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
 - 9. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

10. ASTM E 3121 – Standard Test Methods for Field Testing of Anchors in Concrete or Masonry

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (MNL-66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.
 2. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (MNL-66), shall be furnished for all deformed bar reinforcing used in masonry. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, locations, spacing and splicing of the bars.
 3. Mill test certificates - 3 copies of each.
 4. Description of the reinforcing steel manufacturer's marking pattern.
 5. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
 6. Proposed supports for each type of reinforcing.
 7. Request to use splices not shown on the Drawings.
 8. Request to weld reinforcement.
 9. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' performance, including International Code Council–Evaluation Services Report (ICC-ES ESR)..
 10. Request for placement of column dowels without the use of templates.
 11. Request and procedure to field bend or straighten partially embedded reinforcing.
 12. International Code Council–Evaluation Services Report (ICC-ES ESR) for dowel adhesives.
 13. Certification that all installers of dowel adhesive systems in horizontal to vertically overhead applications are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.
 14. Adhesive dowel testing plan.

1.05 QUALITY ASSURANCE

- A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.
- B. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information.
- C. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards, or equivalent, for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.
- D. Special inspections for adhesive dowels shall be conducted in accordance with the manufacturer's instructions and Specification Section 01 45 33 – Special Inspections. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

PART 2 – PRODUCTS

2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 deformed billet-steel reinforcing unless noted otherwise. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type, and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.
 - 1. Reinforcement to be welded shall conform to the requirements of ASTM A706, Grade 60.
- B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.
- C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.
- D. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

- A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcing during concrete placement. Wire bar supports shall be plastic protected (CRSI Class 1).
- B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

- A. Mechanical couplers shall comply with ACI 318 Type 2 and develop a tensile strength which exceeds 100 percent of the ultimate tensile strength and 125 percent of the yield strength of the reinforcing bars being spliced. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.
- B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied by the same coupler manufacturer.
- C. Hot forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio, or approved equal. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.
- D. Tension-compression mechanical splices may only be used where shown on the Drawings or where specifically approved by the Engineer. Tension-compression mechanical splices shall be shear screw coupling sleeve type. Acceptable mechanical couplers are Bar Lock L-series or XL-series couplers by Dayton Superior, Dayton, Ohio, or approved equal.
- E. Dowel bar mechanical splices shall only be used at construction joints where shown on the Drawings or where specifically approved by the Engineer. Acceptable dowel bar mechanical couplers are the DBDI Splicing System by Dayton Superior, Dayton, Ohio, or approved equal.
- F. Where the threaded rebar to be inserted into the coupler reduces the diameter of the bar, the threaded rebar piece and all components of the coupler system shall be provided by the same coupler manufacturer.
- G. Mechanical couplers shall have a valid evaluation report from ICC-ES in accordance with the Building Code.
- H. All mechanical couplers shall be installed in accordance with the manufacturer's recommendations.

2.04 DOWEL ADHESIVE SYSTEM

- A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions.
- B. All holes shall be drilled in accordance with the manufacturer's instructions except that core drilled holes shall not be permitted unless specifically allowed by the Engineer. Cored holes, if allowed by the manufacturer and approved by the Engineer, shall be roughened in accordance with manufacturer's requirements.
- C. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with manufacturer's instructions prior to installation of adhesive and reinforcing bar.
- D. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be dry, or water saturated unless otherwise permitted by the engineer. If water saturated installation is approved, appropriate reduction factors in accordance with manufacturer's design requirements should be considered. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer.
- E. Injection of adhesive into the hole shall be performed in a manner to minimize the formation of air pockets in accordance with the manufacturer's instructions.
- F. Embedment Depth:
 - 1. The embedment depth of the bar shall be as shown on the Drawings. Although all manufacturers listed below are permitted, the anchor design shall be as shown on the Drawings Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.
 - 2. Where the embedment depth is not shown on the Drawings, the embedment depth shall be determined to provide the minimum allowable bond strength equal to the tensile strength of the rebar according to the manufacturer's ICC-ES ESR.
 - 3. The embedment depth shall be determined using design parameters listed below. In no case shall the embedment depth be less than the minimum, or more than the maximum, embedment depths stated in the manufacturer's ICC-ES ESR.
 - 4. Design of adhesive anchor system shall be based on the following parameters:
 - a. Actual compressive strength of concrete.
 - b. Cracked concrete state.
 - c. Dry or water saturated condition for installation.

- d. Base material temperature between 40- and 104-degrees Fahrenheit.
 - e. Installation with either a hammer drill with carbide bit or hollow-drill bit system drilling methods.
 - f. Minimum age of concrete of 21 days at time of installation.
- G. Engineer's approval is required for use of this system in locations other than those shown on the Drawings.
- H. The adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories and shall be "HIT-HY 200 Adhesive Anchoring System" as manufactured by Hilti, Inc. "SET-3G Epoxy Adhesive Anchors" as manufactured by Simpson Strong-Tie Co. or "Pure 110+ Epoxy Adhesive Anchor System" by DeWalt. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved.
- I. All individuals installing dowel adhesive systems in horizontal to vertically overhead applications shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program, or equivalent.

PART 3 – EXECUTION

3.01 FABRICATION

- A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.
- B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.
- C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved to be bent in the field. Reinforcing bars shall not be straightened or bent in a manner that will injure the material. Heating of bars will not be permitted.
- D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

3.02 DELIVERY, STORAGE AND HANDLING

- A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.

- B. Reinforcing steel shall be stored above ground on platforms or other supports and shall always be protected from the weather by suitable covering. Reinforcing steel shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.
- D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where delay in depositing concrete occurs, reinforcing shall be inspected again and if necessary recleaned.

3.03 PLACING

- A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or plastic protected (CRSI Class 1) metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.
- B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.
- C. Tie wires shall be bent away from the forms to provide the specified concrete coverage.
- D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.
- E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.
- F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.
- G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.

- H. Reinforcing shall not be straightened or bent unless specifically shown on the drawings. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.
- I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations and as required in Article 2.04 above. A representative of the manufacturer must be on site prior to adhesive dowel installation to provide instruction on proper installation procedures for all adhesive dowel installers. Testing of adhesive dowels shall be as indicated below. If the dowels have a hook at the end to be embedded in subsequent work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate adhesive dowel testing while maintaining required hook embedment in subsequent work.
- J. All adhesive dowel installations in the horizontal or overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI Adhesive Anchor Installer Certification program, or equivalent, per ACI 318-11 D.9.2.2 or ACI 318-14 17.8.2.2. Current AAI Certificates must be submitted to the Engineer for approval prior to commencement of any adhesive anchor installations.
- K. Adhesive Dowel Testing
 - 1. At all locations where adhesive dowels are shown on the Drawings, at least 10 percent of all adhesive dowels installed shall be tested to 80% of the yield load of the reinforcing bar, with a minimum of one tested dowel per group.
 - 2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values, and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) prior to conducting any testing. Proof testing procedures shall be in accordance with ASTM E 3121.
 - 3. Where Contract Documents indicate adhesive dowel design is the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. The Contractor shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable.
 - 4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the load test. Dowels exhibiting damage shall be removed and replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be load tested.
 - 5. Load testing of adhesive dowels shall be performed by an independent testing laboratory hired directly by the Contractor. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

3.04 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.
- B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer. Splices shall also meet requirements of Section 2.03.
- E. Mechanical couplers for dowel bar mechanical splices at construction joints which are located at a joint shall be a type which can be set either flush or recessed from the concrete surface. The couplers shall be sealed during concrete placement to eliminate concrete, or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.05 WELDING OF REINFORCEMENT

- A. Welding of reinforcement shall only occur where shown on the Drawings or where specifically approved by the Engineer.
- B. Welding shall comply with all requirements of AWS D1.4.
- C. Welding shall be performed by certified welders in conformance with AWS D1.4.
- D. Material of reinforcement to be welded shall be as specified in Section 2.01.A.1.

3.06 INSPECTION

- A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.
- B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

3.07 CUTTING OF EMBEDDED REBAR

- A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Provide all labor, equipment, materials, and services necessary for the manufacture, transportation, and placement of all plain and reinforced concrete work, as shown on the Drawings or as required by the Engineer.
- B. The requirements in this section shall apply to the types of concrete listed below. See Article 2.11 for concrete mix design and properties of concrete.
 - 1. Class A1 Concrete: Normal weight structural concrete to be used in all structures qualifying as environmental concrete structures designed in accordance with ACI 350 including pump stations, tanks, basins, process structures, and any structures containing fluid or process chemicals, or other materials used in treatment process.
 - 2. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 21 00 – Reinforcing Steel
- C. Section 03 15 00 – Concrete Accessories
- D. Section 03 15 16 – Joints in Concrete
- E. Section 03 35 00 – Concrete Finishes
- F. Section 03 39 00 – Concrete Curing
- G. Section 03 60 00 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2021 International Building Code
2. ACI 214 – Guide to Evaluation of Strength Test Results of Concrete
3. ACI 301 – Specifications for Structural Concrete
4. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 305 – Specification for Hot Weather Concreting
6. ACI 306 – Standard Specification for Cold Weather Concreting
7. ACI 309R – Guide for Consolidation of Concrete
8. ACI 318 – Building Code Requirements for Structural Concrete and Commentary
9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
10. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
11. ASTM C 33 – Standard Specification for Concrete Aggregates
12. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
13. ASTM C 42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
14. ASTM C 88 – Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
15. ASTM C 94 – Standard Specification for Ready-Mixed Concrete
16. ASTM C 114 – Standard Test Method for Chemical Analysis of Hydraulic Cement
17. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
18. ASTM C 138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
19. ASTM C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete
20. ASTM C 150 – Standard Specification for Portland Cement
21. ASTM C 157 - Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete

22. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete
23. ASTM C 192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
24. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
25. ASTM C 260 – Standard Specification for Air-Entraining Admixtures for Concrete
26. ASTM C 295 – Standard Guide for Petrographic Examination of Aggregates for Concrete
27. ASTM C 457 – Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete
28. ASTM C 494 – Standard Specification for Chemical Admixtures for Concrete
29. ASTM C 595 – Standard Specification for Blended Hydraulic Cements
30. ASTM C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
31. ASTM C 989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
32. ASTM C 1012 – Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution
33. ASTM C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
34. ASTM C 1157 – Standard Performance Specification for Hydraulic Cement
35. ASTM C 1260 – Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
36. ASTM C 1567 – Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
37. ASTM C 1579 – Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)
38. ASTM C 1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
39. ASTM C 1609 – Standard Test Method for Flexural Performance of Fiber Reinforced Concrete (Using Beam with Third-Point Loading)

40. ASTM C 1778 – Standard Guide for Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 1. Sources of all materials and certifications of compliance with specifications for all materials.
 2. Certified current (less than 6 months old) chemical analysis (mill test report) of the Portland Cement or Blended Cement to be used. The chemical analysis must include the equivalent alkali content of the Portland Cement or Blended Cement. For Type IL cement, submit updated cement mill test reports every 6 months while active concrete work is being performed.
 3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.
 4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.
 5. Manufacturer's data on all admixtures stating compliance with required standards.
 6. Concrete mix design for each class of concrete specified herein.
 7. Verification that concrete mix and individual constituents in concrete meet requirements for NSF 61 approval for potable water applications where required.
 8. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.
 9. Drying shrinkage test results from trial concrete mixes.

1.05 QUALITY ASSURANCE

- A. Tests on materials used in the production of concrete shall be required as specified in Part 2 – Products. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.
- B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner. Where historical data is utilized for mix design verification, submit certified cement chemical analysis (mill test report) for the historical concrete.
- C. Field quality control tests, as specified in Article 3.11, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and

tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field-Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

PART 2 – PRODUCTS

2.01 nsf/ANSI Standard 61 certified concrete

- A. All admixtures used in concrete where the concrete is uncoated and in contact with potable water shall be individually tested and confirm to follow NSF/ANSI Standard 61.

2.02 HYDRAULIC CEMENT

A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.03 or 2.04, respectively.
2. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.
3. Portland Cement shall also meet performance requirements of ASTM C 1157.

B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement), Type IS (Portland Slag Cement), or Type IL (Portland Limestone Cement) conforming to ASTM C 595.
2. Type IP cement shall be an inter-ground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.
3. Type IS cement shall be an inter-ground blend of Portland Cement and slag cement in which the slag cement constituent is between 30% and 40% of the weight of the total blend.
4. Type IL cement shall be an inter-ground blend of Portland Cement and limestone in which the limestone constituent is between 5% and 15% of the weight of the total blend.
5. Fly ash, slag cement, and limestone used in the production of blended cements shall meet the requirements of Articles 2.03, 2.04, and 2.05 respectively.
6. Cements meeting ASTM C 1157 shall not be used in manufacture of blended cements.

7. Blended cement shall meet the Physical Requirements of Tables 2 and 3 of ASTM C 595 including the requirements for high sulfate resistance in Table 3 as tested per ASTM C1012.
- C. Different types of cement shall not be mixed, nor shall they be used alternately except when authorized in writing by the Engineer. For Type IP, Type IS or Type I/II cement, different brands of cement or the same brand from different mills may be used alternately. For Type IL cement, use of a different cement brand or same brand from a different mill requires resubmittal of the mix design with current mill test report for review. A resubmittal will be required if different cements are proposed during the Project.
- D. Cement shall be stored in a suitable weather-tight building to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.03 FLY ASH

- A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618. Fly ash shall be considered as a supplemental cementitious material.
- B. For fly ash to be used in the production of Type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.
- C. Where reactive aggregates as defined in Article 2.08 are used in the concrete mix, the fly ash constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of fly ash shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where fly ash is used, the minimum fly ash content shall be 15%.
- D. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.04 SLAG CEMENT

- A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.
- B. Where reactive aggregates as defined in Article 2.08 are used in concrete mix, the slag cement constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of slag cement shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where Slag

Cement is used, the minimum Slag Cement content shall be 30%, and the maximum Slag Cement content shall be 40%.

- C. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.
- D. Additional slag cement shall not be included in concrete mixed with Type IS or IP cement.

2.05 PORTLAND LIMESTONE CEMENT (TYPE IL)

- A. Portland Limestone Cement (Type IL) cement shall meet the requirements of ASTM C 595.
- B. Limestone used for blended cement Type IL shall be naturally occurring and meet the requirements of ASTM C 33.
- C. Fly ash or slag cement shall be used with Type IL cement to meet requirements for durability, ASR resistance, sulfate resistance, and use for environmental structures, as specified herein.

2.06 CONCRETE ALKALI LOADING

- A. All concrete mixes containing potentially reactive aggregates shall have a maximum alkali loading of the concrete of 3.0 pounds per cubic yard.
- B. The alkali loading of concrete is the Portland Cement equivalent alkali content multiplied by the Portland Cement content of the mix in pounds per cubic yard divided by 100. The Portland Cement equivalent alkali content shall be included in the certified chemical analysis of the Portland Cement.
- C. Means of evaluating alkali loading of concrete and proportioning constituents of concrete to minimize alkali loading of content shall also conform to the guidelines of ASTM C1778.

2.07 WATER

- A. Water used for mixing concrete shall be clear, potable, and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts, and other impurities.
- B. Water shall not contain more than 100 PPM chloride.
- C. Water shall not contain more than 500 PPM dissolved solids.
- D. Water shall have a pH in the range of 4.5 to 8.5.
- E. Water shall meet requirements of ASTM C 1602.

2.08 AGGREGATES

- A. All aggregates used in normal weight concrete shall conform to ASTM C 33.
- B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.
- C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel, or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.
- D. For Class A4 and A7 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.
- E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.
- F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.
- G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology like sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.
 - 1. Non-reactive aggregates shall meet the following requirements:
 - a. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:
 - 1) Optically strained, micro-fractured, or microcrystalline quartz, 5.0%, maximum.
 - 2) Chert or chalcedony, 3.0%, maximum.
 - 3) Tridymite or cristobalite, 1.0%, maximum.
 - 4) Opal, 0.5%, maximum.
 - 5) Natural volcanic glass in volcanic rocks, 3.0%, maximum.
 - 2. Concrete mixed with reactive aggregates shall meet the following requirements:
 - a. If aggregates are deemed potentially reactive as per ASTM C1778 and fly ash or slag cement is included in proposed concrete mix design, proposed

concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

- b. If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.
 - c. If the proposed aggregates are deemed potentially reactive, the concrete mix shall be evaluated and confirmed to meet the requirements for concrete alkali loading as stipulated in Section 2.06.
- H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.
 - I. Lightweight aggregate for Class C concrete shall conform to ASTM C330 and shall be Stalite by Carolina Stalite Company or equivalent approved expanded slate produced by the rotary kiln method. Maximum aggregate size shall be 1/2 inch.

2.09 ADMIXTURES

- A. Admixtures containing intentionally added chlorides shall not be used.
- B. Admixtures containing 1,4 Dioxane shall not be used
- C. Air entraining admixture shall be added to all concrete unless noted otherwise. The air entraining admixture shall conform to ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be collected, and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.
- D. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set, and enhancing durability. Admixtures permitted shall conform to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.
 - 1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are "Eucon Series" by the Euclid Chemical Company, "Master Pozzoloth Series or Master Polyheed Series" by Master Builders Solutions, and "Plastocrete Series" by Sika Corporation.
 - 2. High range water reducer shall conform to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at the batch plant and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured, and pressure injected into the mixer as a single

dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are "Eucon 37" or Plastol 5000 by the Euclid Chemical Company, "Master Rheobuild 1000 or Master Glenium Series" by Master Builders Solutions, and "Daracem 100 or Advaflow Series" by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are "MasterSet AC 534 or MasterSet FP 20" by Master Builders Solutions, "Accelguard 80/90 or NCA" by the Euclid Chemical Company and "Daraset" by W.R. Grace.
 4. A retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type B or D. Acceptable products are "Eucon NR or Eucon Retarder 100" by the Euclid Chemical Company, "MasterSet R Series or MasterSet DELVO Series" by Master Builders Solutions, and "Plastiment" by Sika Corporation.
 5. Workability Retaining Admixture shall conform to ASTM C 494, Type S. The admixture shall retain concrete workability without affecting time of setting or early-age strength development. Acceptable products are "MasterSure Z 60" by Master Builders Solutions, ViscoFlow-2020 by Sika Corporation, PLASTOL AMP-X3 by Euclid Chemical Company, or equal.
- E. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.
- F. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

2.10 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures, and water used in the concrete mixes shall be based on laboratory trial mixes in conformance with ACI 301. Trial mixes shall also conform to Article 3.01 of this Specification. Trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.
- B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

1. Compressive Strength (28-Day)

Concrete Class A1	4,500 psi (min.), 6500 psi (max.)
Concrete Class A6, A7	6,000 psi (min.), 8,000 psi (max.)
Concrete Class B	3,000 psi (min.), 5000 psi (max.)

2. Water/cementitious materials ratio, by weight

	Maximum	Minimum
Concrete Class A1	0.42	0.39
Concrete A6, A7		
Concrete Class B	0.50	0.39

3. Slump range

- a. 4" nominal unless high range water reducing admixture is used.
- b. 10" max if high range water reducing admixture is used.

4. Air Content

Concrete Class A1, A2, A4, A5, A6, A7	6% ±1.5%
Concrete Class B	3% Max (non-air-entrained)

C. Lightweight concrete (Class C) shall be composed of cement, lightweight aggregate, sand, water, and admixtures, and shall conform to the following requirements:

1. Compressive Strength (28-Day) - 4,000 psi (min.), 6,000 psi (max.)
2. Minimum Cementitious Materials Content - 550 lb/cy
3. Air Content - 6% ±1.5%
4. Maximum Slump - 4"-8" after addition of high range water reducer
5. Maximum Equilibrium Density - 115 PCF
6. Lightweight aggregate shall be presoaked for 48 hours prior to mixing concrete.

PART 3 – EXECUTION

3.01 TRIAL MIXES

- A. Trial mixes shall be used to confirm the quality of a proposed concrete mix in accordance with ACI 301. An independent qualified testing laboratory designated and retained by the Contractor shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement, supplementary cementitious materials, and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

- B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and density (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. ". If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.02 SHRINKAGE TESTS

- A. Concurrent with the trial batch requirements stated in Article 3.01, the testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein. Shrinkage testing is only required for concrete to be used for environmental concrete structures (Class A1).

- B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows.
 - 1. Remove specimens from molds at an age of 23 hours \pm 1 hour after trial batching.
 - 2. Place specimens immediately in water at 70 °F \pm 3 °F for at least 30 minutes.
 - 3. Measure within 30 minutes thereafter to determine original length, then submerge in saturated lime water at 73 °F \pm 3 °F.

4. At age seven days, measure to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).
 5. Store specimens immediately in a humidity-controlled room maintained at $73\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$ and $50\text{ percent} \pm 4\text{ percent}$ relative humidity for the remainder of the test.
 6. Make and report separately measurements to determine shrinkage expressed as base length percentage for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
- C. Compute the drying shrinkage deformation for each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation for the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage for any specimen departs from the average test age for that test by more than 0.0004 inch, disregard the results obtained from that specimen. Report results from the shrinkage test to the nearest 0.001 percent of shrinkage. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered part of the normal compression tests for the project.
- D. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.
- E. If the trial batch specimens do not meet both the strength and shrinkage requirements, revise the mix designs and/or materials and retest.

3.03 PRODUCTION OF CONCRETE

- A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready-mix concrete plant or from a site mixed plant. In selecting the source for concrete production, the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.
- B. Ready-Mixed Concrete
1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.
 2. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter

shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed within the time requirements stated in Article 3.04 of this Section.
6. Every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:
 - a. Date and truck number
 - b. Ticket number
 - c. Mix designation of concrete
 - d. Cubic yards of concrete
 - e. Cement brand, type, and weight in pounds
 - f. Weight in pounds of fine aggregate (sand)
 - g. Weight in pounds of coarse aggregate (stone)
 - h. Air entraining agent, brand, and weight in pounds and ounces
 - i. Other admixtures, brand, and weight in pounds and ounces
 - j. Water, in gallons, stored in attached tank

- k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio
 - l. Water, in gallons, used (by truck driver)
 - m. Time of loading
 - n. Time of delivery to job (by truck driver)
7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.
8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Site Mixed Concrete shall only be used where specifically approved by the Engineer.
2. Scales for weighing concrete ingredients shall be accurate when in use within ± 0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.
3. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:
- a. Cement, fly ash, or slag cement ± 1 percent
 - b. Water ± 1 percent
 - c. Aggregates ± 2 percent
 - d. Admixtures ± 3 percent
4. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
5. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the

recommended revolutions per minute and shall be operated in accordance therewith.

6. Mixers with a rated capacity of one cubic yard or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.
7. Except as provided below, batches of one cubic yard or less shall be mixed for not less than one minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.
8. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.
9. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.
10. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.
11. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if recommended by the manufacturer.
12. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
13. Addition of retarding admixtures shall be completed within one minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.
14. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.04 CONCRETE PLACEMENT

- A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.
- B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints

shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice, and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures required.

- C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.
- D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.
- E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix meeting all specified requirements.
- F. Concrete shall be conveyed as rapidly as practical to the point of deposit by methods which prevent the separation or loss of the ingredients. The concrete shall be deposited so that additional handling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates unless workability-retaining admixtures are included and approved by the Engineer. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.10 of this Section.
- G. Where concrete is conveyed to position by chutes, a continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.
- H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds.

- I. Placing of concrete shall be regulated so the pressure caused by the wet concrete shall not exceed that used in the design of the forms.
- J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet, and enough tremies shall be placed in the form to ensure the concrete remains level.
- K. When placing concrete which will be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.
- L. Concrete shall be placed to thoroughly embed all reinforcement, inserts, and fixtures.
- M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. Concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.
- N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.
- O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. Vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration shall not be continued in any one location to the extent that pools of grout are formed.
- P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall ensure that each layer is placed while the previous layer is soft or plastic, so the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.
- Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

- R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and water stops, and/or any proposed deviations from the stated requirements to the Engineer for review and approval.
- S. Concrete shall not be placed during rains sufficiently heavy or prolonged to prevent washing of mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.05 PLACING FLOOR SLABS ON GROUND

- A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.
- B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing, the temperature shall be raised and maintained above 50° long enough to remove all frost from the subgrade.
- C. The subgrade shall be moist at the time of concreting. If necessary, the subgrade shall be dampened with water in advance of concreting, but no free water shall remain standing on the subgrade nor any muddy or soft spots when the concrete is placed.
- D. Thirty-pound felt-paper shall be provided between edges of slabs-on-ground and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.
- E. Contraction joints shall be provided in slabs-on-ground at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03 15 16 – Joints in Concrete.
- F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03 35 00 – Concrete Finishes. Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

3.06 PLACING CONCRETE UNDER PRESSURE

- A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall

produce a continuous stream of concrete without air pockets. To obtain the least line resistance, the layout of the pipeline system shall contain minimum bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

- B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.
- C. No aluminum parts shall be in contact with the concrete during the placing of concrete under pressure.
- D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a material's testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used during construction, and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.
- E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
- G. The minimum diameter of the hose (conduits) shall be four inches.
- H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.
- I. Concrete samples for quality control in accordance with Article 3.11 will be taken at the placement (discharge) end of the line.

3.07 ORDER OF PLACING CONCRETE

- A. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

3.08 CONCRETE WORK IN COLD WEATHER

- A. Cold weather concreting procedures shall conform to the requirements of ACI 306.1.
- B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed these minimum values by more than 20°F, unless otherwise approved by the Engineer.
- C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature greater than 100°F. to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.09 CONCRETE WORK IN HOT WEATHER

- A. Hot weather concreting procedures shall conform to the requirements of ACI 305.1.
- B. When air temperatures exceed 85°F., or when extremely dry or high wind conditions exist even at lower temperatures, the Contractor and the Contractor's concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing, and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation, and the Engineer reserves the right to modify the proposed measures consistent with the requirements herein. All necessary materials and equipment shall be in place prior to each placing operation.
- C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.
- D. The temperature of the concrete mix when placed shall not exceed 95°F.
- E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being considered. Stockpiled aggregates shall be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, the ice must be entirely melted prior to addition of the water to the dry mix.
- F. Delivery schedules shall be carefully considered in advance to ensure concrete is placed as soon as practical after mixing. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within

60 minutes from the time the concrete is batched, unless workability-retaining admixtures are included and approved by the Engineer.

- G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

3.10 QUALITY CONTROL

A. Field Testing of Concrete

1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.
2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material, or labor costs due to such occurrences.
2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Density

1. Samples of freshly mixed concrete shall be tested for density by the materials testing consultant in accordance with ASTM C 138.
2. Density tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.
3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31, and C 39, except as modified herein.
2. In general, one sampling shall be taken for each placement more than five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.
3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy themselves that such information shown is correct.
4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the cylinders made in any four consecutive working days and to protect the specimens from falling over, being jarred, or otherwise disturbed during the period of initial curing. The box shall be erected, furnished, and maintained by the Contractor. The box shall be equipped to provide the moisture conditions and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. The curing box shall be placed in an area free from vibration such as pile driving and traffic of all kinds and such that all cylinders are shielded from direct sunlight and/or radiant heating sources. No concrete requiring testing shall be delivered to the site until the storage curing box has been provided. Cylinders shall remain undisturbed in the curing box until ready for delivery to the testing laboratory, but not less than sixteen hours.
5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of cylinders with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day the curing box contains cylinders. Temperature shall be recorded a minimum of three times a day with one recording at the start of the day and one recording at the end of the day.

6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.
7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.
2. The strength level of concrete will be considered satisfactory if the following conditions are satisfied.
 - a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.11).
 - b. No individual compressive strength test result falls below the minimum specified strength by more than 500 psi.
3. If any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.
4. If condition 3.11.F.2.b is not met, additional tests in accordance with Article 3.11, Paragraph H shall be performed.
5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:
 - a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
 - b. Maintain or add temporary structural support as required.
 - c. Correct the mix for the next concrete placement operation, if required to remedy the situation.
6. All concrete which fails to meet the ACI requirements, and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.

H. Additional Tests

1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.
2. If the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.11, Paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.
 - a. Three cores shall be taken for each sample in which the strength requirements were not met.
 - b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.
 - c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.
 - d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.
 - e. The diameter of core specimens should be at least 3 times the maximum nominal size of the coarse aggregate used in the concrete but must be at least 2-inches in diameter.
 - f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.
 - g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.
 - h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.
3. If the concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM C 457.

3.11 CARE AND REPAIR OF CONCRETE

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Care shall be taken to prevent the drying of concrete and to avoid roughening or

otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

- B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.
- C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.
- D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system unless other means of repair are deemed necessary and approved. All repair work shall be performed at no additional cost to the Owner.
- E. Concrete which fails to meet the strength requirements as outlined in Article 3.11, Paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses, and exposure conditions for the area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. Section 03 60 00 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 – Specifications for Structural Concrete for Buildings
 - 2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Manufacturer's literature on all products specified herein.

PART 2 – PRODUCTS

2.01 CONCRETE FLOOR SEALER

- A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by Master Builders Solutions.

2.02 CONCRETE LIQUID DENSIFIER AND SEALANT

- A. Concrete liquid densifier and sealant shall be a high performance, deeply penetrating concrete densifier and sealant. Product shall be odorless, colorless, VOC-compliant, non-yellowing silicate based solution designed to harden, dustproof, and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is silicate. Acceptable products are Diamond Hard by the Euclid Chemical Company, and Seal Hard by L&M Construction Chemicals, and Masterkure HD 200 WB by Master Builders Solutions.

2.03 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

- A. Non-oxidizing heavy-duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or MasterTop 200 by Master Builders Solutions.

2.04 NON-SLIP FLOORING ADDITIVE

- A. Non-slip flooring additives for slip resistant floors shall be non-metallic. Non-slip flooring additives shall be MasterTop 120SR by Master Builders Solutions, A-H Alox by Anti-Hydro, or Euco Grip by the Euclid Chemical Company.

PART 3 – EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

- A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.06 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. See Article 3.05 for surfaces to receive paint or protective coatings. The Engineer shall be the sole judge of acceptability of all concrete finish work.
 - 1. Type I - Rough: All fins, burrs, offsets, marks, and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bug holes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing

the hole solidly with cement grout. Cement grout shall consist of one-part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been pre-dampened over an extended amount of time to reach the condition of saturated surface dry (SSD), a slurry consisting of one part cement (including an appropriate quantity of white cement to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.
3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type II finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded using a carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

- A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.
 1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2" minimum deep grooves prior to final set.
 2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The

finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than the finish obtained with a wood float. The finish shall be obtained by power or band floating with cork floats.
4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.
5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.
6. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring additive concurrently with the application of a Type "D" finish and/or installation of floor sealants. Application procedure shall be in accordance with manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.

3.03 CONCRETE SEALERS

- A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein. Concrete sealers and densifiers shall not be used as concrete curing compounds. Curing compounds, when allowed, shall be in accordance with Section 03 39 00 – Concrete Curing.
- B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer's requirements.
- C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.
- D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.

E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

- A. Formed surfaces of equipment pads shall receive a Type III finish.
- B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 FINISHES FOR SURFACES TO RECEIVE PAINT OR COATINGS

- A. Surfaces indicated or specified to receive paint or special coatings shall be prepared per specifications in Division 09. All products applied to the concrete surfaces during the placement, finishing, and curing process shall be compatible with the painting or coating system as required by the manufacturer.

3.06 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09 97 00 – Special Coatings)	I
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 feet below water surface to bottom of wall	I
From top of wall to 1 feet below water surface	II
Exterior concrete walls below grade	I
Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures, and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	II
All interior exposed concrete walls and vertical surfaces	III
Interior exposed ceiling, including beams	III
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B
All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D or E
Exterior top surface of tank roof.	B
All interior finish floors of buildings and structures which are not continuously or intermittently wet	D

Item	Type of Finish
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E

END OF SECTION

SECTION 03 39 00
CONCRETE CURING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 11 00 – Concrete Formwork
- B. Section 03 30 00 – Cast-In-Place Concrete
- C. Section 03 35 00 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ACI 301 – Specifications for Structural Concrete
 - 2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. ACI 305.1 – Specification for Hot Weather Concreting
 - 4. ACI 306.1 – Standard Specification for Cold Weather Concreting
 - 5. ACI 308.1 – Specification for Curing Concrete
 - 6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete
 - 7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.

1. Proposed procedures for protection of concrete under wet weather placement conditions.
2. Proposed normal procedures for protection and curing of concrete.
3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.
4. Proposed method of measuring concrete surface temperature changes.
5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 – PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

- A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m² when applied at manufacturer's recommended volume for square feet of area. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company.
- B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

2.02 EVAPORATION REDUCER

- A. Evaporation reducer shall be "MasterKure ER 50" by Master Builders Solutions, or "Euco-Bar" by Euclid Chemical Company.

PART 3 – EXECUTION

3.01 PROTECTION AND CURING

- A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
- B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provisions shall be made for maintaining the concrete in a moist condition for at least a 7-day period thereafter, except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, and localized drying will not be permitted.

- C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of seven days.
- D. The Contractor shall use one of the following methods to ensure that the concrete remains in a moist condition for the minimum period stated above.
 - 1. Ponding or continuous fogging or sprinkling.
 - 2. Application of mats or fabric kept continuously wet.
 - 3. Continuous application of steam (under 150°F).
 - 4. Application of sheet materials conforming to ASTM C171.
 - 5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.
- E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.
- F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

- A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03 30 00 – Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.
- B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or slag cement. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.
- C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.
- D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

- A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sunshades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.
- B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.
- C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.
- D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least six (6) additional days using one of the methods listed in paragraph 3.01D.
- E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

- A. Curing compound shall be used only where specifically approved by the Engineer. . Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.
- B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in strict accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Coverage rates for the curing and sealing compound shall be in strict accordance with manufacturer's requirements for the specific type of finish required. For rough surfaces, apply in two directions at right angles to each other.

END OF SECTION

SECTION 03 40 00
PRECAST CONCRETE

PART 1 – GENERAL

1.01 REQUIREMENTS

- A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 33 05 61 – Utility Structures
- B. Section 03 21 00 – Reinforcing Steel
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 35 00 – Concrete Finishes
- E. Section 03 39 00 – Concrete Curing
- F. Section 03 60 00 – Grout
- G. Section 05 10 00 – Metal Materials
- H. Section 05 05 23 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of the Bid.
 - 1. International Building Code
 - 2. ACI 301 – Structural Concrete for Buildings
 - 3. ACI 318 – Building Code Requirements for Structural Concrete
 - 4. ASTM D2240 – Standard Test for Rubber Property – Durometer Hardness
 - 5. PCI Standard MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

6. PCI Standard MNL-120 - Design Handbook Precast and Prestressed Concrete
7. PCI Standard MNL-123 – Manual on Design of Connections for Precast Prestressed Concrete
8. PCI Standard MNL-124 – PCI Design for Fire Resistance of Precast Prestressed Concrete

1.04 SUBMITTALS

- A. The Contractor shall submit the following for review in accordance with Section 01 33 00 – Submittal Procedures.
 1. Shop Drawings for all precast members including layout and dimensions, unit locations, unit identification marks, reinforcement connection details, support items, dimensions, openings, temporary supports, and relationship to adjacent materials. Indicate design loads, deflections, cambers, bearing requirements, and special conditions. The submittal shall be sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located.
 2. A list of the design criteria used by the manufacturer for all manufactured, precast items.
 3. Design calculations, showing at least the design loads and stresses on the item and assumptions, shall be submitted. Calculations shall be sealed by a Professional Engineer currently registered in the in the State or Commonwealth in which the project is located.
 4. Certified reports for all lifting inserts, indicating allowable design loads.
 5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

- A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing, and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.
- B. Manufacturer Qualifications: The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of

production. Certification is required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.

- C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years' experience in precast concrete work.
- D. Erector of precast and prestressed items shall be a company specializing in erecting members specified with a minimum of three years documented experience and specifically approved by the fabricator of precast and prestressed members specified.

PART 2 – PRODUCTS

2.01 DESIGN REQUIREMENTS

- A. Precast and prestressed members shall be designed to support superimposed loads indicated on the Drawings and as required by current Building Code of the State or Commonwealth in which the project is located. Design shall also consider loads and stresses due to handling, transporting, and erecting of units.
- B. Maximum live load deflections for members shall be L/240 for roof members and L/360 for floor members.
- C. Members shall be designed to accommodate construction tolerances, and clearances of intended openings.
- D. Design shall be performed by a qualified professional engineer registered in the State or Commonwealth in which the project is located.
- E. Fire Rating shall be established in accordance with PCI MNL 124 to achieve the fire ratings required on the Drawings for floor, wall, and roof assemblies.

2.02 CONCRETE

- A. Concrete materials including Portland cement, aggregates, water, and admixtures shall conform to Section 03 30 00 – Cast-in-Place Concrete. Precast concrete manufacturer has option of using Type III cement for prestressed concrete members to expedite release of prestressing and erection.
- B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.
- C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4,500 psi for fluid containing and other environmental concrete structures and 4,000 for other structural concrete structures, unless otherwise specified.

2.03 GROUT

- A. Grout for joints between members shall be a cement grout in conformance with Section 03 60 00 – Grout.
- B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.04 REINFORCING STEEL

- A. Reinforcing steel used for precast concrete construction shall conform to Section 03 21 00 – Reinforcing Steel.

2.05 PRESTRESSING STRANDS

- A. Prestressing strands shall be 7-wire, stress-relieved, high-strength strands Grade 250K or 270K.

2.06 STEEL INSERTS

- A. Steel inserts shall be in accordance with Section 05 10 00 – Metal Materials.
- B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized.

2.07 WELDING

- A. Welding shall conform to Section 05 05 23 – Metal Fastening.

2.08 BEARING PADS

- A. Neoprene bearing pads shall conform to the requirements of A4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be nonlaminated pads having a nominal Shore A durometer hardness of 70 in accordance with ASTM D2240. Adhesive for use with neoprene pads shall be an epoxy-resin compound compatible with the neoprene having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikadur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.
- B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

PART 3 – EXECUTION

3.01 FABRICATION AND CASTING

- A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true, and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position. Form materials shall be steel and the systems free from leakage during the casting operation.
- B. Manufacturer shall maintain plant records and quality control program during production of precast members.
- C. Ensure reinforcing steel anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on shop drawings.
- D. Openings with a 10-inch minimum dimension in either direction shall be cast in place. Smaller openings shall be considered in the design and arrangement of reinforcement and strands. These openings may be field cut, but only in the size and location approved by the precast manufacturer.
- E. All cover of reinforcing shall be the same as detailed on the Drawings.
- F. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.
- G. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.
- H. Concrete shall be finished in accordance with Section 03 35 00 – Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.
- I. Curing of precast members shall be in accordance with Section 03 39 00 – Concrete Curing. Use of a membrane curing compound will not be allowed.
- J. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

- A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28-day compressive strength and a period of at least 5 days has elapsed since casting.
- B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.
- C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.
- D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.
- E. Precast concrete members shall not be used as storage areas for other materials or equipment.
- F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

- A. Erection shall be carried out by the manufacturer or under the manufacturer's supervision using labor, equipment, tools, and materials required for proper execution of the work.
- B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.
- C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.
- D. Connections which require welding shall be properly made in accordance with Section 05 05 23 – Metal Fastening.
- E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.
- F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on

the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).

- G. No Contractor, Subcontractor or any of their employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.
- H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

END OF SECTION

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SECTION 03 60 00

GROUT

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 01 and Division 02 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. CRD-C 621 – Corps of Engineers Specification for Non-shrink Grout
2. ASTM C 33 – Standard Specification for Concrete Aggregates
3. ASTM C 109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)
4. ASTM C 531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing
5. ASTM C 579 – Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing
6. ASTM C 827 – Standard Test Method for Early Volume Change of Cementitious Mixtures
7. ASTM C 1107 – Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.
2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of grout used in the work.

1.05 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to ensure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.
 - a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days, and any additional times as appropriate.
 - b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time as appropriate.
2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.
3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall

consist of one-part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4000 psi.
3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness. Cement grout used for surfaces swept in by a mechanism shall also contain micro-synthetic fibers in accordance with Section 03 30 00.
4. Sand shall conform to the requirements of ASTM C33.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "NS Grout" by the Euclid Chemical Company, "SikagROUT 212" by Sika Corporation, "Conspec 100 Non-Shrink Non-Metallic Grout" by Conspec, "MasterFlow 928" by Master Builders Solutions.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "E3 Series" by Euclid Chemical, "MasterEmaco ADH 1090 RS" by Master Builders Solutions.
2. Epoxy grout shall be modified as required for each application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be "Sikadur 42, Grout-Pak" by Sika Corporation, or "MasterFlow 648" by Master Builders Solutions.

2.02 CURING MATERIALS

- A. Curing materials shall be as specified in Section 03 39 00 – Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 – EXECUTION

3.01 GENERAL

- A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.
 - 1. Cement grout shall be used for grout toppings and for patching of fresh concrete, when approved by the Engineer. Grout toppings swept in by equipment mechanisms shall contain micro-synthetic fibers as specified in Section 03 30 00.
 - 2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.
 - 3. Epoxy grout shall be used for bonding new concrete to hardened concrete.
 - 4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.
- B. New concrete surfaces to receive cement grout shall be as specified in Section 03 35 00 – Concrete Finishes, and shall be cleaned of all dirt, grease, and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping, or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03 39 00 – Concrete Curing.
- C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

3.02 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

- A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be placed from one side only and allowed to flow across to the open side to avoid air-entrapment.

END OF SECTION

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SECTION 05 05 23
METAL FASTENING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 13 – Galvanizing

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. 2021 International Building Code
 - 2. AC 193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
 - 3. AC 308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
 - 4. ACI 318 – Building Code Requirements for Structural Concrete
 - 5. ACI 355.2 – Qualifications of Post-Installed Mechanical Anchors in Concrete
 - 6. ACI 355.4 – Qualifications of Post-Installed Adhesive Anchors in Concrete
 - 7. AISC – RCSC Specification for Structural Joints Using High Strength Bolts
 - 8. AISC – Code of Standard Practice

 - 9. AWS D1.1 – Structural Welding Code – Steel
 - 10. AWS D1.2 – Structural Welding Code – Aluminum
 - 11. AWS D1.6 – Structural Welding Code – Stainless Steel

12. Aluminum Association – Specifications for Aluminum Structures
13. ASTM A572/A572M-94C – Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
14. ASTM A36 – Standard Specification for Carbon Structural Steel
15. ASTM A489 – Standard Specification for Eyebolts
16. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts
17. ASTM D1785 – Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
18. ASTM E3121 – Standard Test Methods for Field Testing of Anchors in Concrete or Masonry
19. ASTM F436 – Standard Specification for Hardened Steel Washers
20. ASTM F467 – Standard Specification for Nonferrous Nuts for General Use
21. ASTM F593 – Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
22. ASTM F594 – Standard Specification for Stainless Steel Nuts
23. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
24. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimension

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
 2. Anchor design calculations sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. Only required if design not shown on Contract Drawings.
 3. Manufacturer's installation instructions.
 4. Copy of valid certification for each person who is to perform field welding.
 5. Certified weld inspection reports, when required.

6. Welding procedures.
7. Installer qualifications.
8. Certification of Installer Training.
9. Inspection Reports.
10. Results of Anchor Proof Testing.
11. Manufacturer's Literature for Resistance of Adhesive to Appropriate Chemical Exposure, where deemed necessary.

1.05 QUALITY ASSURANCE

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. Evaluation Report: A current Evaluation Report from an independent testing and evaluation agency (ITEA) shall be submitted for all anchors that will be used on this project. The ITEA producing the evaluation report shall be accredited in accordance with the requirements for ITEA's in ACI 355.2 (mechanical anchors) or 355.4 (adhesive anchors). Acceptable ITEA's include but are not necessarily limited to the International Code Council Evaluation Service (ICC-ES) and the International Association of Plumbing and Mechanical Officials Uniform Evaluation Service (IAPMO-UES).
- C. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installers for anchor installations shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.
- D. Installer Training: For concrete anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:
 1. Hole drilling procedure.
 2. Hole preparation and cleaning technique.
 3. Adhesive injection technique and dispenser training/maintenance.
 4. Concrete adhesive anchor preparation and installation.
 5. Proof loading/torquing.
- E. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with

AWS D1.2. All stainless-steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

- F. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
- G. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.
- H. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.
- I. Special inspections for concrete adhesive anchors shall be conducted in accordance with the manufacturer's instructions and Section 01 45 33 – Special Inspections. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

PART 2 – PRODUCTS

2.01 ANCHOR RODS

- A. Anchor rods shall conform to ASTM F1554 Grade 55 except where stainless steel or other approved anchor rods are shown on the Drawings or stated herein. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A. Washers shall meet the requirements of ASTM A436.
- B. All anchors into concrete shall be cast-in-place anchors unless specifically referenced otherwise on Drawings.
- C. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot dipped galvanized in accordance with ASTM F1554.
- D. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM F3125, Grade A325 Type 1 or Grade F1852 Type 1. Bolts, nuts, and washers shall meet the requirements of RCSC "Specification for Structural Joints Using High Strength Bolts".

- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot dipped galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593 for alloy groups 1 and 2, Condition CW1, or ASTM F-3125. All fasteners for aluminum and stainless steel members that are underwater, in confined areas containing fluid, and in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts, washers, and lock washers shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS

- A. General
 - 1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used. Where one of the types listed below is specifically called for on the Drawings, only that type shall be used. If no specific type is indicated on the Drawings, the concrete anchor shall be a cast-in-place anchor. The determination of anchors equivalent to those listed below shall be based on test data performed by an approved independent testing laboratory. Two types of anchors shall be used:
 - a. Mechanical anchors include any of the following anchors:
 - 1) Expansion anchors shall be mechanical anchors of the wedge, sleeve, or drop-in type that are set by expanding against the sides of the drilled hole.
 - 2) Screw anchors are mechanical anchors that derive tensile holding strength by the mechanical interlock provided by threads cutting into the concrete during installation. Screw anchors shall be one-piece, heavy duty screw anchors with a finished head.
 - b. Adhesive anchors shall consist of threaded rods anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two-part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.
 - 2. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Mechanical anchors shall conform to the requirements of ACI 355.2 or

alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the International Building Code and ACI 318 Appendix D requirements as applicable, including seismic test requirements.

3. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire-resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or be only as anchors for non-structural elements.
4. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Wedge Anchors:

- a. Do not use when subjected to vibration.
- b. Do not use in exterior locations or locations subjected to freezing.
- c. Do not use in submerged, intermittently submerged, or buried locations.
- d. Suitable for use in overhead applications.

C. Screw Anchors:

- a. Do not use when subjected to vibration.
- b. Do not use in exterior locations or locations subjected to freezing.
- c. Do not use in submerged, intermittently submerged, or buried locations.
- d. Suitable for use in overhead applications.

D. Sleeve Anchors:

- a. Do not use when subjected to vibration.
- b. Do not use in exterior locations or locations subjected to freezing.
- c. Do not use in submerged, intermittently submerged, or buried locations.
- d. Suitable for use in overhead applications.

E. Undercut Anchors:

- a. Suitable for use where subjected to vibration.
- b. Do not use in exterior locations or locations subjected to freezing.
- c. Do not use in submerged, intermittently submerged, or buried locations.

- d. Suitable for use in overhead applications.

F. Adhesive Anchors in Concrete:

- a. Suitable for use where subjected to vibration.
- b. Suitable for use in exterior locations or locations subjected to freezing.
- c. Suitable for use in submerged, intermittently submerged, or buried locations.
- d. Do not use in overhead applications, unless otherwise shown or approved by Engineer.
- e. Suitable for use in chemical areas provided manufacturer's literature confirms appropriate chemical resistance.
- f. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

G. Adhesive Anchors in Masonry (where cells have been fully grouted)

- a. Suitable for use where subjected to vibration.
- b. Suitable for use in exterior locations or locations subjected to freezing.
- c. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.
- d. Suitable for use in precast hollow core planks provided cores have been fully grouted.

H. Concrete Anchor Design:

1. Basis of design shall include the following design parameters:
 - a. Actual compressive strength of concrete.
 - b. Cracked concrete conditions.
 - c. Dry or water saturated installation conditions.
 - d. Base material temperature between 40- and 104-degrees Fahrenheit.
 - e. Installation with hammer drill or hollow-drill bit system drilling methods.
 - f. Installation not prior to 21-day minimum age of concrete.
2. An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is

indicated on the Drawings, the anchors shall be installed to the prescribed size, spacing, embedment depth, and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

a. The Contractor shall submit design with sealed calculations and drawings performed by an Engineer currently registered in the State or Commonwealth in which the project is located. Anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.

b. Embedment Depth

1) Minimum anchor embedment shall be as indicated on the Drawings unless anchor design is stipulated to be by Contractor or equipment provider. The provider of equipment including pumps, blowers, etc. shall provide anchor design including size of anchors, pattern, and embedment depth. If the equipment provider is unable to provide design of embedment depth, the design shall be provided by the contractor using the loads furnished by the equipment provider. Although all manufacturers listed are permitted, the design shall be as indicated on the Drawings. Engineer shall evaluate the required embedment, and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

2) Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).

3) The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long-term temperature of 110 degrees F, and maximum short-term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

I. Anchors:

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Power-Stud+SD1" or "Power-Stud+ SD-2" by DeWalt.

- b. Screw Anchors: Screw anchors shall be “KWIK HUS-EZ”, “KWIK HUS-EZ-I”, or “KWIK HUS-EZ CRC” by Hilti, Inc., “Titen HD” or “Stainless Steel Titen HD” by Simpson Strong-Tie Co., or “Screw-Bolt+” by DeWalt.
- c. Sleeve Anchors: Sleeve anchors shall be “HSL-3 Heavy Duty Sleeve Anchor” by Hilti, Inc. or “Power-Bolt +” by DeWalt.
- d. Shallow Embedment Internally Threaded Insert (3/4” max embedment): “Mini-Undercut +Anchor” by DeWalt, “HDI-P-TZ” by Hilti, Inc. or approved equal.
- e. Concrete Undercut Anchors: Concrete undercut anchors shall be “HDA Undercut Anchors” by Hilti, Inc, “DUC Ductile Undercut Anchor”, by USP Structural Connectors, or approved equal.
- f. Mechanical anchor systems shall comply with ACI 355.2 or alternatively the latest revision of AC 193 and shall have a valid evaluation report in accordance with the applicable building code.

2. Adhesive Anchors:

- a. Adhesive anchors shall be “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET-3G Epoxy Adhesive Anchors” by Simpson Strong-Tie Co., or “Pure 110+ Epoxy Adhesive Anchor System” by DeWalt.
- b. Adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Adhesive anchor systems shall comply with ACI 355.4 or alternatively the latest revision of ACI 308 and shall have a valid evaluation report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

J. Concrete Anchor Materials:

- 1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per anchor manufacturer’s recommendations but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.
- 2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be manufactured from stainless steel unless noted otherwise. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

3. Nuts, washers, lock washers and other hardware shall be of a material to match the anchors.

2.05 WELDS

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.06 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.07 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.08 ANTISEIZE LUBRICANT

- A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 – EXECUTION

3.01 MEASUREMENTS

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 FASTENER INSTALLATION

- A. Anchor Rods, Concrete Anchors, and Masonry Anchors
 1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by securing rods where concrete will be placed and positioned by means of a rigidly secured template. Overhead anchors, and base plates or elements being anchored, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.
 2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the

capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Post-installed concrete anchors shall not be used in place of cast-in-place anchor rods without Engineer's approval.
4. All stainless-steel threads shall be coated with anti-seize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with RCSC "Specification for Structural Joints Using High Strength Bolts". All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Stainless Steel Bolts

1. Where connections indicate the use of stainless-steel bolts, the bolts shall be installed to the snug tight condition. Connections shall include stainless steel washers under both the bolt head and the nut head. Lock washers shall be utilized for all connections and shall be placed under the nut head.

D. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and ambient temperature at time of installation shall be at least 50 degrees F.
2. Concrete Anchor Testing:
 - a. At all locations, at least 10 percent of all concrete anchors installed shall be proof tested to 80% of the yield strength of the anchor rod, with a minimum of one tested anchor per anchor group.
 - b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E3121 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.
 - c. Where Contract Documents indicate anchor design to be the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. Documentation shall also be submitted

indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E3121.

- d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.
 - e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.
3. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.
 4. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed, cored holes shall be roughened in accordance with manufacturer requirements. If hammer drills are used to drill holes in slabs, the drills shall be equipped with a depth stop device. The depth of hole shall be the minimum depth required for anchor embedment and development of required capacity. Prior to drilling, the contractor shall use GPR or other means to confirm anchor installation will not interfere with reinforcement or embedded items, especially electrical conduit. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.
 5. All adhesive anchor installations shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-11 D.9.2.2. Current AAI Certificate must be submitted to the Engineer of Record prior to commencement of any adhesive anchor installations.

E. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be isolated via an approved dielectric.
2. All stainless-steel bolts shall be coated with anti-seize lubricant.

3.03 WELDING

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.
- B. Welded stud connectors shall be installed in accordance with AWS D1.1.
- C. Welds shown on the Drawings with a field weld symbol shall be field welded. All other welds shall be shop welded unless specifically approved by the Engineer.

3.04 INSPECTION

- A. High strength bolting will be visually inspected in accordance with RCSC "Specification for Structural Joints Using High Strength Bolts". Rejected bolts shall be either replaced or retightened as required.
- B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.
- C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

- A. The Contractor shall not cut embedded rebar cast into concrete during installation of post-installed anchors without prior approval of the Engineer.

END OF SECTION

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SECTION 05 10 00
METAL MATERIALS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Materials for fasteners are included in Section 05 05 23 – Metal Fastening.
- B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM A36 – Standard Specification for Structural Steel
- B. ASTM A47 – Standard Specification for Malleable Iron Castings
- C. ASTM A48 – Standard Specification for Gray Iron Castings
- D. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- E. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- F. ASTM A276 – Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
- G. ASTM A307 – Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- H. ASTM A446 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
- I. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- J. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

- K. ASTM A529 – Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)
- L. ASTM A536 – Standard Specification for Ductile Iron Castings
- M. ASTM A570 – Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- N. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- O. ASTM A992 – Standard Specification for Structural Steel Shapes
- P. ASTM A666 – Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
- Q. ASTM A1085 – Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
- R. ASTM B26 – Standard Specification for Aluminum-Alloy Sand Castings
- S. ASTM B85 – Standard Specification for Aluminum-Alloy Die Castings
- T. ASTM B108 – Standard Specification for Aluminum-Alloy Permanent Mold Castings
- U. ASTM B138 – Standard Specification for Manganese Bronze Rod, Bar, and Shapes
- V. ASTM B209 – Standard Specification for Aluminum-Alloy Sheet and Plate
- W. ASTM B221 – Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- X. ASTM B308 – Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
- Y. ASTM B574 – Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod
- Z. ASTM F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
- AA. ASTM F593 – Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

- A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

- A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials, the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 – PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

- A. Material types and ASTM designations shall be as listed below:

Steel W, C, and MC Shapes	A992
Steel HP Shapes	A572 Grade 50
Steel M and S shapes and Angles, Bars, and Plates	A36
Rods	F 1554 Grade 55
Pipe - Structural Use	A53 Grade B
Hollow Structural Sections	A500 Grade C or A1085 Grade A
Cold-Formed Steel Framing	A 653

2.02 STAINLESS STEEL

- A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.
- B. Material types and ASTM designations are listed below:

Plates and Sheets	ASTM A167 or A666 Grade A
Fasteners (Bolts, etc.)	ASTM F593

2.03 DISSIMILAR METALS

- A. Dielectric isolation shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			•	•	•	•	•	•	•
Galvanized Steel			•	•	•	•	•	•	•
Aluminum	•	•		•	•	•	•	•	•
Cast Iron	•	•	•				•	•	•
Ductile Iron	•	•	•				•	•	•
Mild Steel/ Carbon Steel	•	•	•				•	•	•
Copper	•	•	•	•	•	•			•
Brass	•	•	•	•	•	•			•
Stainless Steel	•	•	•	•	•	•	•	•	

1. "•" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 – GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.
- B. Work shall include but may not be limited to guard posts, ladders, floor access doors.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 23 – Metal Fastening
- C. Section 05 05 13 – Galvanizing
- D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. 2021 International Building Code
 - 2. AISC – Specification for Structural Steel Buildings
 - 3. AISI – Specifications for the Design of Cold-Formed Steel Structural Members
 - 4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Complete fabrication and erection drawings of all metalwork specified herein.
 - 2. Other submittals as required in accordance with Section 05 10 00 – Metal Materials and Section 05 05 23 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used in metal fabrications shall conform to Section 05 10 00 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used in metal fabrication shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

PART 3 – EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05 05 23 – Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in Section 09 90 00 – Painting.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- C. Metal work shall be field painted when as specified in accordance with Section 09 90 00
– Painting.

END OF SECTION

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SECTION 05 53 00
GRATINGS, CHECKERED FLOOR PLATES, AND ACCESS DOORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and access doors in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 23 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. 2021 International Building Code
 - 2. Aluminum Association Specifications for Aluminum Structures
 - 3. Occupational Safety and Health Administration (OSHA) Regulations
 - 4. ANSI/NAAMM MBG 531 – NAAMM Metal Bar Grating Manual
 - 5. ASTM C1802 – Design, Testing, Manufacture, Selection, and Installation of Fabricated Metal Access Hatches for Utility, Water, and Wastewater Structures

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Complete fabrication and erection Drawings of all gratings, floor plates, and access doors specified herein.
 - 2. For checkered floor plates, structural calculations signed and sealed by a currently registered Professional Engineer in the State or Commonwealth in which the Project is located verifying the proposed floor plate meets the minimum load and deflection requirements stipulated herein.

3. For access doors provided by a manufacturer not specifically named herein, structural calculations signed and sealed by a Professional Engineer currently registered in the State or Commonwealth in which the Project is located verifying the proposed access door meets the minimum load and deflection requirements stipulated herein. For access doors provided by a named manufacturer, sealed calculations are not required provided the applicable ASTM C1802 load rating is clearly indicated in the submittal for each proposed product.
4. Other submittals as required in accordance with Section 05 10 00 – Metal Materials and Section 05 05 23 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

- A. Metal materials used for gratings, floor plates, and access doors shall conform to Section 05 10 00 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for gratings, floor plates, and access doors shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

2.03 ACCESS DOORS

- A. General
 1. Door opening sizes, number, and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the dimensions of the openings in the concrete. Clear opening dimensions shall be no smaller than six inches less than the concrete opening.
 2. All doors shall be aluminum unless otherwise noted.
 3. All door components shall have a minimum tensile yield strength of 23,000 psi and a minimum compressive yield strength of 21,000 psi. Yield strengths shall be indicated on both the structural calculations and the fabrication drawings.
 4. Openings larger than 42 inches in either direction shall have double leaf doors.
 5. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
 6. All doors shall be provided with an automatic hold-open arm with release handle.
 7. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.

8. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.
9. All doors specifically required to be watertight shall be installed with a continuous gasket.
10. Access door frames with integral gutter systems shall be equipped with a 1-1/2-inch minimum drainpipe located by the manufacturer. The drainpipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.
11. All doors shall be clearly marked with the information listed below. Markings shall be indicated on metal or plastic tags permanently attached to the door or frame or shall be permanently painted or printed.
 - a. The manufacturer's name or trademark, location, and telephone contact number.
 - b. The manufacturer's model number and ASTM designation.
 - c. The design load level as indicated in ASTM C1802. If the design requires deviation from the Load Level requirements specified in ASTM C1802, a description of the modifications shall be included.
 - d. The nominal door opening dimensions and/or the manufacturer's model number.
 - e. Date of manufacture and/or serial number.

B. Floor, Wet Well and Dry Pit Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.
2. Doors shall be designed for flush mounting and for easy opening from both inside and outside.
3. All doors shall have an enclosed compression spring assist and open to 90 degrees.
4. Doors not required to support traffic loading shall meet the requirements of ASTM C1802 for Load Level 2 – Pedestrian Load as a minimum and the following:
 - a. Doors shall be designed to carry a minimum service level live load of 300 psf or a concentrated load of 600 pounds applied over a 5.50 inch by 5.50 inch

area, whichever produces the greatest stress, unless indicated otherwise on the Drawings. Loading shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.

- b. Live load deflection shall be limited to $L/200$ of the span, but not greater than $3/16$ inch.
- c. Unless otherwise noted, exterior doors shall have an integral gutter system and be Type "FDDP" by Nystrom, Type "W1S" or "W2S" by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., or Type "THG" or "THG-D", by Thompson Fabricating LLC, or Type "J-AL" or "JD_AL" by the Bilco Company.
- d. Unless otherwise noted, interior doors shall be Type "FDNP" by Nystrom, Type "S1S" or "S2S" by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., or Type "TH" or "TH-D", by Thompson Fabricating LLC.

2.04 FALL THROUGH PREVENTION SYSTEM

- A. All checkered floor plates and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except as noted on the Contract Drawings. Checkered floor plates and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum live load, unless noted otherwise.

PART 3 – EXECUTION

3.01 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05 05 23 – Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All gratings, checkered floor plates, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.
- C. Where access doors utilize leveling bolts, or are placed on irregular surfaces, and are not to be embedded in concrete, the area beneath the frames shall be fully grouted with non-shrink grout to create a uniformly loaded bearing surface.
- D. Grating shall not be field cut or modified unless approved by Engineer.
- E. Grating shall not be used for equipment support or anchorage.

END OF SECTION

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SECTION 06 51 00
GLASS FIBER AND RESIN FABRICATIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all fiberglass items as specified herein and as shown on the Drawings. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 05 23 – Metal Fastening
- B. Section 07 90 00 – Joint Fillers, Sealants, and Caulking
- C. Section 09 90 00 – Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
 - 2. ASTM D3647 – Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition
 - 3. ASTM D3917 – Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes
 - 4. ASTM D4385 – Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
 - 5. ASTM E84 – Standard Test Method for Determining Surface Burning Characteristics for Building Materials

1.04 SUBMITTALS

- A. The Contractor shall submit shop drawings showing fabrication details and a Performance Affidavit for all items specified herein in accordance with Section 01 33 00 – Submittal Procedures and Section 46 00 00 – Equipment General Provisions.
- B. Certification of compliance with ASTM Standards.
- C. Where specifically requested, design drawings and calculations sealed by a currently Registered Professional Engineer in the State or Commonwealth in which the project is located. FRP grating floor system and guard and handrail systems will require these sealed items.

1.05 QUALITY ASSURANCE

- A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.
- B. The Contractor is responsible for ensuring that the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.
- C. Manufacturer shall provide a 3-year warranty on all FRP products against defect in material and workmanship.

PART 2 – MATERIALS

2.01 GENERAL

- A. All manufacturing shall occur in the United States. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples.
- B. Ultraviolet light resistive resins shall be used for all exterior locations and where specified.
- C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.
- D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

2.02 GRATING AND TREADS

- A. Fiberglass grating and treads shall be furnished and installed in areas shown on the Drawings including all FRP angle supports, fasteners and accessories. Gratings and

treads shall consist of extruded bearing bars positioned and locked by crossbars. Grating and treads shall be installed in accordance with the manufacturer's recommendations.

- B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.
- C. Fasteners shall not project above the walking surface.
- D. Fiberglass grating and treads shall be manufactured of isophthalic polyester fire retardant (ISOFR) resin except for applications where vinyl ester fire retardant (VEFR) resin is specifically required on the Contract Drawings. Grating and treads shall be produced by IKG Industries, Fibergrate, Inc., American Grating with Bedford Plastics, Strongwell, or equal.
- E. Grating shall be designed for a uniform loading of 100 PSF over the gross projected area with deflection limited to 0.375" or grating span/240 whichever is less. Fiberglass or PVC support beams shall be provided as required to meet deflection criteria.
- F. The grating and tread supplier shall supply all shelf support angles, embedded angles with anchors, concrete anchors and necessary 316 stainless steel grating clips.
- G. Treads shall be designed for a 300 lb. concentrated load at midspan. Treads shall be furnished with integral nosing.

2.03 GRATING FLOOR SYSTEM

- A. Contractor shall be responsible for design of Grating Floor System. Provide drawings and structural calculations both sealed by a Professional Engineer currently registered in the State or Commonwealth where the project is located. Fiberglass grating floor system shall be furnished and installed in areas shown on the Drawings and shall include all FRP angle supports, FRP adjustable pedestal supports, FRP cross bracing, fasteners, and accessories as required for a complete system. Grating shall consist of bidirectional molded FRP gratings. Grating and supports shall be provided by a single manufacturer and installed in accordance with the manufacturer's recommendations to provide a level walking surface.
- B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.
- C. Fasteners shall not project above the walking surface.
- D. Fiberglass grating and supports shall be manufactured of ISOFR except for applications where VEFR is specifically required on the Contract Drawings. Grating and supports shall be produced by Fibergrate, Inc., American Grating with Bedford Plastics, Strongwell, or equal.

- E. Grating and supports shall be designed for a uniform loading of 100 psf. Grating deflection shall be limited to 0.25”.
- F. Grating clips and metal fasteners shall be Type 316 stainless steel.

2.04 FIBERGLASS WEIRS AND BAFFLES

- A. Fiberglass reinforced polyester (FRP) weirs and baffles shall be installed where shown on the Drawings. All weir plates, scum baffle plates, buff plates, and cover plates shall be FRP. A "low profile" resin system shall be used to ensure that all surfaces are smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas to provide increased corrosion and weather resistance. All edges shall be sealed in the mold. Resin shall be ISOFR. Plate thickness shall be 3/8 inch minimum, or as shown on the Drawings. FRP weirs and baffles shall be blue green in color. Each section shall be of the depth and overall length as indicated on the Drawings. Each section shall be provided with mounting holes at 12 inches on center, unless shown otherwise on the Drawings, to provide a minimum 2 inch vertical or horizontal adjustment. Sections shall be secured to walls or trough with Type 316 stainless steel anchor rods and 5-inch minimum diameter washers to prevent short-circuiting. Ends of weir plates shall be secured with 6-inch-wide butt plates arranged to allow for horizontal expansion. Type 316 stainless steel anchor rods shall be furnished by the FRP supplier.
- B. Laminate shall contain a glass content of 30+2% using Type "E" glass with chrome or silane finish. Powdered reinforcements shall consist of 47.5+1% of resin mixture. Final laminate thickness shall be within +10 percent of the nominal specified thickness. Ultraviolet absorbers shall be added to the resin to prevent deterioration from sunlight. Where weir plates are of nonstandard length or nonstandard mounting hole configuration, such machined or cut edges shall be resin sealed with seal mix.
- C. All items shall be manufactured in accordance with ASTM D2996 and ASTM D3917. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples to verify that the laminate has the following minimum physical properties:

Requirement	Minimum Results	Test Method
Tensile Strength (psi)	14,000	ASTM D638
Flexural Strength (psi)	25,000	ASTM D790
Flexural Modulus (psi)	1.0 x 10 ⁶	ASTM D790
Impact, Notched, Izod, (foot pound per inch)	15.0	ASTM D256
Barcol Hardness	40	ASTM D2583
Water Absorption, (% after 24 hours)	0.2 Max	ASTM D570

Requirement	Minimum Results	Test Method
Average coefficient of thermal expansion (inch per inch per °F)	10.5 x 10 ⁶	ASTM D696

- D. The procedure used in determining the above properties shall be in accordance with the ASTM Standards, Part 35, using the method designated above. Hardness tests shall be made on the resin rich surfaces of the test samples. Test coupons shall be prepared in accordance with the appropriate ASTM test method.
- E. Baffle plate lengths shall be made to fit the installation, but lengths shall not exceed 10 feet. Lap plates shall be provided to secure the ends of the plates. Type 316 stainless steel hardware shall be furnished by the FRP supplier for securing baffle plates to 316 SS support brackets and lap plates. Type 316 SS anchor bolts shall be used for anchoring scum baffle supports to the wall.
- F. All items furnished under this Section shall be as manufactured by MFG Construction and Water Products, Warminster Fiberglass, NEFCO, or equal.

2.05 CONNECTIONS

- A. All connections shall be non-corrosive, non-staining, and concealed where practical, as detailed on the Drawings or specified herein.
- B. Fiberglass fasteners shall be "Fibrebolt", as manufactured by Strongwell, Inc., or equal.
- C. All metal fasteners shall be Type 316 stainless steel, except where Hastelloy C-276 or fiberglass fasteners are specifically required on the Contract Drawings.
- D. Holes for bolts and screws shall be drilled.
- E. Joints exposed to weather shall be formed to exclude water.
- F. Design and installation of fiberglass items shall provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, and provide close fitting of sections.

2.06 STRUCTURAL SHAPES AND FLAT SHEETS

- A. Shapes shall conform to sizes indicated on Drawings and shall be ISOFR except where VEFR is specifically required on the Contract Drawings. Shapes shall be manufactured by Strongwell, Inc., Fibergate Composite Structures, or equal.

- B. Metal bolted connections shall be made with stainless steel bolts except where Hastelloy C bolts or fiberglass fasteners are specifically required on the Contract Drawings. Bolts shall conform to Section 05 05 23 – Metal Fastening.
- C. Adhesive bonded connections shall be made with a compatible epoxy adhesive following manufacturer's instructions. Adhesive bonded connections shall only be used where bolted connections are not feasible.

PART 3 – EXECUTION

3.01 FABRICATION

- A. All cut edges and holes shall be sealed with a compatible resin.
- B. All FRP items shall conform to the dimensions indicated on the Drawings.
- C. All fiberglass items described in this Section shall be supplied by a manufacturer that normally fabricates such items so that appearance and quality control are acceptable.

3.02 HANDLING, TRANSPORTING, AND STORING

- A. All FRP items shall be properly packed, labeled and stored in accordance with Specifications and as directed by the Engineer.

3.03 INSTALLATION

- A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.
- B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.
- C. Weirs and baffles shall be installed in full accordance with the manufacturer's recommendations. Joints between weir plates and concrete and butting weir plates shall be watertight. The Contractor shall seal all weirs with caulk approved by the Engineer after weirs are set, checked for level, and are within specified tolerances.

END OF SECTION

SECTION 06 80 00

LADDERS

PART 1 – GENERAL

1.01 REQUIREMENT

- A. This specification is for a pultruded fiberglass ladder system in compliance with OSHA 1910.27.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.
 - 1. 2021 International Building Code
 - 2. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:
 - a. ASTM D-638-Tensile Properties of Plastics
 - b. ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics
 - c. ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
 - d. ASTM D-495-High Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation
 - e. ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics
 - f. ASTM E-84-Surface Burning Characteristics of Building Materials
 - g. THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) Code of Federal Regulations (CFR), Title 29, Section 1910.27

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. The CONTRACTOR shall furnish shop drawings of all fabricated ladder, cages and accessories in accordance with the provisions of this Section.
 - 2. The CONTRACTOR shall furnish manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location,

lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.

3. The CONTRACTOR shall submit the manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.
4. The CONTRACTOR may be required to submit sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

1.04 QUALITY ASSURANCE

- A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
- B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
- C. Manufacturer shall be certified to the ISO 9001-2008 standard.
- D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

1.05 PRODUCT DELIVERY AND STORAGE

- A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Ladder components shall be Dynarail® as manufactured by Fibergrate Composite Structures Inc. or approved equal.

2.02 METAL FASTENING

- A. All fasteners used for ladders shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

2.03 LADDERS

- A. All ladder side rails, rungs, ladder mounting brackets and cage straps are to be FRP structural shapes manufactured by the pultrusion process. Cage hoops and brackets shall be produced by the open molded hand lay-up method. All structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, bi-directional roving mat and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
- C. Resins shall be DYNAFORM® {ISOFR, an isophthalic polyester or VEFR, a vinyl ester - *choose one*} with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.
- D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- E. All pultruded ladder components shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.
- F. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.
- G. The ladder side rail shall be 1-3/4" square tube with a wall thickness of 1/4" or greater. The rungs shall be 1-1/4" diameter pultruded structural shapes, continuously fluted to provide a non-slip surface. Rungs that are gritted as a secondary operation shall not be permitted. Ladder wall and floor mount shall be fabricated from pultruded angles, 3/8" minimum thickness.
- H. The ladder cage vertical bars shall be 1.5" wide by 5/8" pultruded I-beam shapes to offer protection to workers from exposed hardware. Cage hoops and cage brackets shall be manufactured by the open mold hand lay-up process. All cage hoops shall be 3" wide by 1/4" thick minimum.

- I. Type 316 stainless steel bolts shall be provided for attaching ladder cage vertical bars to hoops, ladder hoops to brackets, ladder cage brackets to the ladder, and wall brackets to the ladder.
- J. All rungs shall be both mechanically attached to the ladder with stainless steel rivets and chemically bonded with epoxy.
- K. All ladder and cage components are to be integrally pigmented yellow. All wall and floor mount brackets shall be Dynaform® ISOFR light gray.
- L. Pultruded structural shapes used in the ladder system are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Method	Value	Units
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5 x 10 ⁶ (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8 x 10 ⁶ (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8 x 10 ⁶ (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5 x 10 ⁵ (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	8.0 x 10 ⁻⁶ (1.4 x 10 ⁻⁶)	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

- M. All fasteners used in the ladder system are to be 316 SS. Rivets will be 18-8 stainless steel.

2.04 LADDER RETRACTABLE SAFETY EXTENSION

1. Where the Contract Documents indicate fixed ladders are required under access doors and checkered floor plates, they shall be provided with “LadderUp, Model LU-4” by Bilco Company, “L1E Ladder Extension” by Halliday Products Inc., or “Ladder Climb-out Device” by Thompson Fabricating.
2. For access doors, the safety extension shall be manufactured from the same material as the access door with telescoping tubular sections that lock automatically when fully extended.

3. Upward and downward movement shall be controlled by a stainless-steel balancing mechanism.
4. Safety extension shall be assembled in strict accordance with manufacturer's recommendations.

PART 3 – EXECUTION

3.01 FABRICATION

- A. All ladders and cages shall be designed and laid out in strict accordance with OSHA 1910.27.
- B. All rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both epoxy and rivets to provide both a chemical and mechanical lock, respectively.
- C. Ladders shall be fully shop assembled. Ladder cages shall be test assembled and drilled to ensure a proper fit in the field. Ladder cage brackets shall remain attached to the ladder for shipping, but ladder cage components shall be disassembled, packaged, and shipped separately to ensure the lowest freight costs and to prevent damage in transit. Cage components shall be bundled with each respective ladder.
- D. The hoop brackets shall be shop attached to the ladder with bolts. The hoops shall be field attached to the hoop brackets.
- E. All cut or machined edges, holes and notches shall be sealed to provide maximum corrosion resistance. All field fabricated cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

3.02 PERFORMANCE REQUIREMENTS

- A. The completed ladder and cage system installation shall meet the following load requirements set forth in OSHA 1910.27. The ladder shall also be capable of supporting a concentrated vertical load of 1,200 pounds applied at the mid-span of the rung. Manufacturer shall be required to provide supporting test data for rung capacity.

3.03 INSTALLATION

- A. Contractor shall be required to assemble and install ladder in strict accordance with manufacturer's assembly drawing and installation brochure.
- B. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

END OF SECTION

SECTION 07 13 50
WATERPROOFING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.
- B. Principal items of work include:
 - 1. Waterproofing on the exterior sides of walls below grade.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:
 - 1. ASTM D146 – Sampling and Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use in Waterproofing and Roofing
 - 2. ASTM D412 – Tests for Rubber Properties in Tension
 - 3. ASTM E96 – Tests for Water Vapor Transmission of Materials in Sheet Form

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
 - 1. Manufacturers product literature, specification data sheets and installation instructions.
 - 2. Samples of composite drainage panel and waterproofing.
 - 3. Complete layout and installation drawings and schedules with clearly indicated dimensions.
 - 4. Detail drawings showing all anchoring details and construction details at corners, penetrations and flashing.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.
- B. Store materials in dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have been damaged and remove from the job site.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products manufactured by one of the following:
 - 1. Grace Construction Products.
 - 2. Carlyle Coating and Waterproofing
 - 3. Polyguard Products.

2.02 PRODUCTS

- A. Waterproofing Membrane: Self-adhering membrane consisting of a minimum 56 mils of rubberized asphalt laminated to a minimum 4 mils of polyethylene to form a minimum of 60 mil membrane. Provide a cold-applied membrane which requires no special adhesives or heating equipment.
- B. Physical Properties

Properties	Test Method	Result
Pliability (@ -25 f)	ASTM D-146	No Effect
Tensile Strength Membrane	ASTM D-412	250 psi min.
Tensile Strength Film	ASTM D-412	4000 psi min.
Elongation	ASTM D-412	300% min.
Puncture Resistance Membrane	ASTM E-154	40 lbs. min.
Puncture Resistance Film	ASTM D-781	250 in. oz. tear
Permeance	ASTM E-96 (B)	0.1 max. grains/sf/hr/in.Hg
Water Absorption	ASTM D-570	0.2 max. (% by weight)

Properties	Test Method	Result
Adhesion to Concrete	ASTM D-903	5.0 lbs./in. width max.

- C. Primer: As recommended by manufacturer.
- D. Mastic: As recommended by manufacturer. Use mastic to seal cut edge terminations.

2.03 COMPOSITE DRAINAGE PANEL

- A. Composite drainage panel: Three dimensional, high impact, polystyrene core with a nonwoven filter fabric bonded to the core. Provide a polymeric sheet adhered to the flat side of the polystyrene core. Extend filter fabric beyond the edges to provide total filtering integrity of the drainage system.
- B. Physical Properties

Properties	Test Method	Result
Compressive Strength (Core)	ASTM D-1621	15,000 psf
Apparent Opening Size (Filter Fabric)	ASTM D-4751	100 United States Standard Sieve
Water Flow Rate (Filter Fabric)	ASTM D-4491	150 gpm/ft
Water Flow (Composite System)	ASTM D-4716	15 gpm/ft. width

- C. Composite System Requirements
 1. Provide one inch flange on longitudinal edge.
 2. Bond filter fabric to each dimple of polymeric core.
 3. Extend filter fabric beyond toe edge of polymeric core to provide total filtering integrity of the drainage system.
 4. System shall be approved for use over waterproofing membrane.

PART 3 – EXECUTION

3.01 EXAMINATION OF SURFACES

- A. Examine all surfaces and installation of work done by other trades.
- B. Coordinate all work under this Section with contiguous work of other trades.

3.02 APPLICATION

- A. Install waterproofing membrane and composite drainage system in strict accordance with manufacturer's printed instructions and recommendations.
- B. Where drainage piping is shown on Drawings, extend systems to allow for proper drainage.
- C. Cover and seal all terminal edges. Cut systems and seal around penetrations.
- D. Provide a written report from the Manufacturer's representative stating that the waterproofing membrane and composite drainage system were installed correctly.

END OF SECTION

SECTION 07 90 00
JOINT FILLERS, SEALANTS AND CAULKING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 15 00 – Concrete Accessories
- B. Section 03 15 16 – Joints in Concrete
- C. Section 08 80 00 – Glass and Glazing

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM C-920 – Elastomeric Joint Sealants
 - 2. ASTM D-1056 – Flexible Cellular Materials – Sponge or Expanded Rubber
 - 3. SWRI – Sealant and Caulking Guide Specification

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
 - 1. Manufacturers literature and installation instructions. Label each product submitted with Type as indicated in paragraph 2.01 A.
 - 2. Color samples of each type of sealant.

1.05 QUALITY ASSURANCE

- A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years of experience.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened labeled packages.
- B. Store materials in location protected from freezing or damages.
- C. Reject and remove from the site materials within broken or damaged packaging.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Sealants

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.
2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by Master Builders Solutions.
3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C920, Type S, Grade NS, Class 50, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by Master Builders Solutions.
4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by Master Builders Solutions.
5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by Master Builders Solutions.
6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.
7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.

8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type M, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, MasterSeal CR 195 by Master Builders Solutions.
- B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.
- C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.
- D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.
- E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.
- F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 – EXECUTION

3.01 QUALITY CONTROL

- A. Coordinate work with details shown on approved shop drawings prepared by other trades.
- B. Verify conditions in the field.
- C. Schedule work to follow closely the installation of other trades.
- D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.
- E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

3.02 PREPARATION

- A. Protect finished surfaces adjoining by using masking tape or other suitable materials.
- B. Clean and prime joints before starting any caulking or sealing work.
- C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.
- D. Joint Requirements

1. All joints and spaces to be sealed in exterior work shall be less than 1/2-inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.

2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4-inch deep, the back-up material may be omitted, a bond breaker substituted and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4-inch depth of the open space in any joint. The following width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

Joint Width	Sealant Depth	
	Minimum	Maximum
1/4 inch	1/4 inch	1/4 inch
Over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
Over 1/2 inch to 1 inch	1/2 inch	Equal to width
Over 1 inch to 2 inches	1/2 inch	1/2 of width

3.03 APPLICATION

- A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.

- B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.

- C. All joints shall be waterproof and weathertight.

- D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.

- E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.

- F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.04 ADJUSTMENT AND CLEANING

- A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.
- B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

3.05 SCHEDULE

Schedule of Sealants

Application	Sealant	Color
Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings.	Type 1	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural stone or other porous building material, unless noted otherwise herein or on Drawings.	Type 2	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints less than 1¼" wide.	Type 2	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints equal or greater than 1¼ inches wide and not to exceed 2".	Type 1	To closely match adjacent surfaces and as selected by the Owner.
Interior – wood trim and finish joints.	Type 5	Color to be selected by Owner
Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes. ¹	Type 4	To closely match adjacent surfaces and as selected by the Owner.
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. ²	Type 2 OR Type 3	To closely match adjacent surfaces and as selected by the Owner.
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. ^{3,4}	Type 1	Manufacturer's standard
Submerged in liquids with high concentration of chlorine (> 2 ppm) or wastewater.	Type 7	Manufacturer's standard

Schedule of Sealants

Application	Sealant	Color
Horizontal Joints exposed to vehicular or pedestrian traffic.	Type 8	To closely match adjacent surfaces.
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the Owner.

¹ Sealant for Laboratory Countertop shall be as recommended by countertop manufacturer.

² Provide UL approved sealants for penetrations thru fire-rated walls and as specified

³ Sealants which will come in contact with potable water shall meet the requirements of NSF 61.

⁴ Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

END OF SECTION

SECTION 26 05 00
BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental to, the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents, and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in, and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

- B. Reference Section 40 61 13 – Process Control System General Provisions and General Requirements in Division 01 for scope of work details as they relate to the Division 40 Instrumentation and Control System Subcontractor.

- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
 - 1. Demolition of electrical equipment and raceway systems as shown on the Drawings.
 - 2. Modifications to existing electrical equipment as shown on the Drawings and as specified herein.
 - 3. Furnish and install low voltage motor control equipment including reduced voltage motor starters and variable frequency drives.
 - 4. Furnish, test, and install power panelboards, lighting panelboards, and other low voltage electrical power distribution equipment.
 - 5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.
 - 6. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.

7. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system.
 8. Furnish and install new lighting systems and wiring devices.
 9. Other electrical work as specified herein and indicated on the Drawings.
- D. All material and equipment shall be the product of an established, reputable, and approved manufacturer; shall be new and of first-class construction; shall be designed and guaranteed to perform the service required; and shall bear the Label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.
- E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.
- F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.
- G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.
- H. All electrical components and systems (e.g., conduit and other raceways, freestanding equipment, etc.) and their anchorage, including electrical equipment foundations, shall be designed to resist the controlling load combination of gravity loads, operational forces, wind forces, seismic forces, thermal loads, and any other applicable forces required in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components. Seismic design shall be in accordance with ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt.

1.02 EQUIPMENT LOCATION

- A. The Drawings show the general location of feeders, transformers, equipment, devices, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting the work and shall arrange such work accordingly. Contractor shall furnish and install such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other

equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.

- B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

1.03 LOCAL CONDITIONS

- A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction (AHJs). All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.
- B. In addition, the Contractor shall relocate all duct banks, lighting fixtures, receptacles, switches, boxes, and other electrical equipment as necessary to facilitate the Work included in this project. Costs for such work shall be included in the Bid.
- C. The Contractor is responsible for coordinating all electric utility equipment installations with the serving electric utility. The Contractor shall furnish and install all electric utility equipment required by the electric utility to be installed by the Contractor whether specifically shown on the Drawings or not.
- D. The Contractor shall furnish and install the following electric utility equipment as a minimum:
 - 1. Concrete transformer/equipment pads constructed in accordance with utility requirements and/or as instructed by the electric utility.
 - 2. Primary and /or secondary conduits/ductbank and manholes.
 - 3. Metering equipment cabinets and/or bases.
 - 4. Conduit and wire required from metering cabinet to metering current transformers and potential transformers.
 - 5. Secondary conductors .
 - 6. Secondary terminations.

- E. The electric utility will furnish and install the following equipment:
 - 1. Primary conductors and terminations.
 - 2. Utility Transformer.
- F. The Contractor is responsible for ensuring all electric utility equipment and construction installed by the Contractor is furnished and installed in accordance with the electric utility's design specifications and requirements. The Contractor is fully responsible for coordinating all required work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the Owner.
- G. The contact person at the serving electrical utility is:

N/A

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures and the requirements of the individual Specification Sections, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts List
 - 4. Proposed Testing Methods and Reports of Certified Shop Tests
 - 5. Reports of Certified Field Tests
 - 6. Manufacturer's Representative's Certification
- B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.
- C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.
- D. Some individual electrical specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations, and exceptions taken to the Drawings and

Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of the applicable specification section(s). In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations and exceptions taken to each Drawing related to the applicable specification section(s).

- E. Submit design for all nonstructural electrical components and systems and their anchorage in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. Unless otherwise noted, all work, equipment, and materials furnished shall conform with the latest available version of the rules, requirements, and specifications of the following:
 - a. Insurance Rating Organization having jurisdiction.
 - b. The serving electric utility company.
 - c. The currently adopted edition of the National Electrical Code (NEC).
 - d. The National Electric Manufacturers Association (NEMA).
 - e. The Institute of Electrical and Electronic Engineers (IEEE).
 - f. The Insulated Cable Engineers Association (ICEA).
 - g. The American Society of Testing Materials (ASTM).
 - h. The American National Standards Institute (ANSI).
 - i. The requirements of the Occupational Safety Hazards Act (OSHA).
 - j. The National Electrical Contractors Association (NECA) Standard of Installation.
 - k. National Fire Protection Association (NFPA).
 - l. International Electrical Testing Association (NETA).

- m. All other applicable Federal, State/Commonwealth, and local laws and/or ordinances.
- 2. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL), if the material and equipment is of the type/class inspected by said laboratories.

B. Nonconformance

- 1. Any paragraph of requirements in these Specifications or Drawings deviating from the rules, requirements, and specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements, and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

- 1. Where applicable, upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

1.06 PERMITS AND INSPECTIONS

- A. The Contractor shall reference the General Conditions and Section 01 11 00 – Summary of Work.

1.07 TEMPORARY LIGHTING AND POWER

- A. The Contractor shall reference the General Conditions and Section 01 51 00 – Temporary Utilities.

1.08 TESTS

- A. Upon completion of the installation, the Contractor shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.
- B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no

cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

- C. Refer to each individual specification section for detailed test requirements.
- D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the startup and testing of any equipment served by that electrical equipment. During the period between the completion of electrical installation and the startup and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.
- E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, personnel, and scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed test procedures for any electrical equipment required as part of the field tests of other systems.

1.09 INFRARED INSPECTION

- A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared inspection to locate and correct all heating problems associated with electrical equipment terminations.
- B. Equipment located in hazardous areas shall be excluded from infrared testing requirements since the equipment in those areas is not intended to be operated while the enclosure is open. The infrared inspection shall apply to all new equipment and existing equipment in non-hazardous areas that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor at no additional cost to the Owner. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor at no additional cost to the Owner.
- C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.
- D. The infrared inspection report shall include both digital photos and infrared (IR) photos positioned side by side. Both the digital and IR photos shall be clear and high quality. Fuzzy, grainy, or poorly illuminated photos are not acceptable. Each IR photo shall be provided with a temperature scale beside it, and an indication of the hot spot temperature in the photo. Reports shall be furnished in a 3-ring binder, with all pages printed in full color, with equipment assemblies separated by tabs.

1.10 PROTECTIVE DEVICE SETTING AND TESTING

- A. The Contractor shall provide the services of a field services organization to adjust, set, calibrate and test all protective devices in the electrical system. The organization shall be a subsidiary of or have a franchise service agreement with the electrical equipment manufacturer. The qualifications of the organization and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.
- B. All protective devices in the electrical equipment shall be set, adjusted, calibrated, and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.
- C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity, and polarity tests of power, protective, and metering circuits. Any minor adjustments, repairs, and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
- D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers' recommended test devices and procedures.
- E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.
- F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults, and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.
- G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.11 POWER SYSTEM STUDIES

- A. The Engineer will provide the Power System studies to the firm providing the protective device setting and testing services. The Contractor shall submit to the Engineer a tabulated listing of all protective devices requiring setting at least three (3) weeks prior to the scheduled date for setting and testing of protective devices. This table shall include the protective device manufacturer, model number, ampere rating (if applicable), instrument transformer ratios, and all other required information.

1.12 SCHEDULES AND FACILITY OPERATIONS

- A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules shall be submitted to the Engineer for review and approval one (1) month prior to any work

beginning. When testing has been scheduled, the Engineer shall be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment shall be coordinated with the Owner/Engineer so as not to affect proper facility operations.

- B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.
- C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.
- D. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01 14 00 – Coordination with Owner's Operations for construction sequencing and specific operational constraint information.

1.13 EQUIPMENT, MATERIALS, AND SPARE PARTS HANDLING AND STORAGE

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01 55 00 – Contractor Access and Parking.
- B. Spare parts lists, included with the shop drawing submittal for each Section, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.
- C. Spare parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

- D. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- E. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

1.14 WARRANTIES

- A. Unless otherwise specified in an individual specification section, all electrical equipment and electrical construction materials shall be provided with a warranty in accordance with the requirements of Section 46 00 00 – Equipment General Provisions and the General Conditions.

1.15 TRAINING

- A. Unless otherwise specified in an individual specification section, all training for electrical equipment shall be provided in accordance with the requirements of Section 46 00 00 – Equipment General Provisions.

PART 2 – PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.
- C. All equipment and materials shall be new, unless indicated or specified otherwise.
- D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, and/or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc. with regard to fire and casualty hazards. Documentation indicating Listing and Labeling by Underwriters Laboratories, Inc., will be accepted as meeting this requirement.
- E. Where the above items are Labeled by (bearing the certification mark of) an OSHA Nationally Recognized Testing Laboratory (NRTL) other than UL, and the NRTL is

authorized by the Occupational Safety and Health Administration (OSHA) to test and certify those items to the same standard(s), then the certification mark of that NRTL shall be considered equivalent to the 'UL' certification mark.

2.02 SUBSTITUTIONS

- A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

2.03 CONCRETE

- A. The Contractor shall furnish all concrete required for the installation of all electrical work. Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 03 of the Specifications.
- B. The Contractor shall provide concrete equipment pads for all free-standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to the Standard Detail for equipment pads shown on the Drawings. Equipment pads shall not have more than 3 inches of excess concrete beyond the edges of the equipment.
- C. The Contractor shall provide concrete foundations for all free-standing electrical apparatus and equipment located outdoors or where floors or slabs do not exist and/or are not or provided by others under this Contract. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of the foundations. Equipment foundations shall be constructed as detailed on the Drawings or if not detailed on the Drawings shall be 6 inches thick minimum reinforced with #4 bars at 12-inch centers each way placed mid-depth. Concrete shall extend 6 inches minimum beyond the extreme of the equipment base and be placed on a compacted stone bed (#57 stone or ABC) 6 inches thick minimum.

2.04 RUBBER INSULATING MATTING

- A. Rubber insulating matting shall be furnished and installed for each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. Matting shall be installed in the front of all equipment and in the rear of equipment that is rear accessible. The mat shall be long enough to cover the full length of the equipment. The mat shall be ¼-inch thick with

beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.

- B. Matting shall be provided for the following equipment:
 - 1. PLC/RTU Enclosures
 - 2. Panelboards

PART 3 – EXECUTION

3.01 CUTTING AND PATCHING

- A. Coordination
 - 1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling, and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.
- B. Damage
 - 1. The Contractor shall perform all chasing, channeling, drilling, and patching necessary to the proper execution of this Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at the Contractor's expense.
- C. Existing Equipment
 - 1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 EXCAVATION AND BACKFILLING

- A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 31.

3.03 CORROSION PROTECTION

- A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

END OF SECTION

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SECTION 26 05 19
LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition all low voltage wire and cable indicated on the Drawings, as specified herein, and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.
- B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.
- C. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 33.16 – Boxes for Electrical Systems
 - 3. Section 26 28 16.16 – Enclosed Switches

1.02 CODES AND STANDARDS

- A. All low voltage wire, cable, and appurtenances shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
 - a. IEEE 1202 – Standard for Flame Testing of Cables.
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire.
 - b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

- c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
 - d. ASTM D69 – Standard Test Methods for Friction Tapes.
 - e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
3. Insulated Cable Engineers Association (ICEA):
- a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification.
 - b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour.
4. National Fire Protection Association (NFPA):
- a. NFPA 70 – National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
- a. UL 13 – Standard for Power-Limited Circuit Cables.
 - b. UL 44 – Thermoset-Insulated Wires and Cables.
 - c. UL 83 – Thermoplastic-Insulated Wires and Cables.
 - d. UL 486A-486B – Standard for Safety Wire Connectors
 - e. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - f. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.
 - g. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
 - h. UL 2250 – Standard for Instrumentation Tray Cable.
 - i. UL 2556 – Wire and Cable Test Methods.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of Field Tests
 - 3. Circuit Logs
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets for the following:
 - a. Wire and cable
 - 1) The product data sheets for wire and cable for up to four (4) manufacturers for each type of wire/cable specified herein will be reviewed if they are submitted at the same time under the same submittal cover for simultaneous review.
 - b. Power and control wire terminations, including wire ferrules
 - c. Instrumentation cable terminations
 - d. Pulling lubricant.
 - 2. Cable pulling calculations (if required).
 - 3. Wiring identification methods and materials.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and

similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 CABLE PULLING CALCULATIONS

- A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for Engineer review and approval when all of the following are true:
 - 1. The amount of cable to be installed will be greater than 200 linear feet between pull points.
 - 2. The installation will have one or more bends.
 - 3. The wire/cable is size #1/0 AWG and larger.
- B. Cable pulling calculations shall be performed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located. Calculations shall define pulling tension and sidewall loading (sidewall bearing pressure values).

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

2.02 POWER AND CONTROL WIRE AND CABLE

- A. Power and control wire shall consist of insulated copper conductors with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.
- B. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size.
- C. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.
- D. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in

accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

- E. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or Engineer approved equal.

2.03 INSTRUMENTATION CABLE

- A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e., groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e., group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).
- C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.
- D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.
- E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.
- F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or Engineer approved equal.

2.04 OTHER CABLES

- A. Category 6 UTP communication cables and fiber optic cables shall be as specified in Specification Section 40 66 00 – Network and Communication Equipment.

2.05 CONDUCTOR IDENTIFICATION

- A. Conductors shall be identified using a color-coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:
1. 480/277V AC Power
 - a. Phase A – BROWN
 - b. Phase B – ORANGE
 - c. Phase C – YELLOW
 - d. Neutral – GREY
 2. 120/208V or 120/240V AC Power
 - a. Phase A – BLACK
 - b. Phase B – RED
 - c. Phase C – BLUE
 - d. Neutral – WHITE
 3. DC Power
 - a. Positive Lead – RED
 - b. Negative Lead - BLACK
 4. DC Control
 - a. All wiring – BLUE
 5. 120 VAC Control
 - a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock. This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above-mentioned equipment from a source outside that equipment.
 6. 24 VAC Control
 - a. All wiring - ORANGE

7. Equipment Grounding Conductor

- a. All wiring - GREEN
- B. Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3 herein. Insulation colors and tape colors shall be in accordance with the color-coding requirements listed above.
- C. Conductors that are part of multi-conductor cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color-coding requirements listed above.

2.06 CABLE PULLING LUBRICANTS

- A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 – EXECUTION

3.01 WIRE AND CABLE INSTALLATION

- A. General
 1. All wire and cable furnished under this Contract, including wire and cable furnished under other Divisions, shall be installed in raceways (e.g., conduit) unless specifically noted otherwise.
 2. Wire and cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation wiring.
 3. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where

indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.

4. Where instrumentation cables are installed in control panels, motor controllers, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.
5. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

B. Splices

1. Splices shall not be allowed in power or control wire and cable unless approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.
2. Splicing materials shall be UL 486A Listed barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.
3. No splicing of instrumentation cable is permitted.

C. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 2-1/2%.

D. Additional Conductor Identification

1. In addition to the color-coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.
2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.

3. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.
4. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.
5. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.
6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.
7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.
8. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that specific conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle using nylon wire ties and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.
9. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.
2. Instrumentation cable shall be racked and bundled separate from AC wiring to maintain the required separation as follows:
 - a. 18 inches for 480/277 VAC wiring
 - b. 12 inches for 208/120 VAC wiring
 - c. 6 inches for 24 VAC wiring

G. Conductor Terminations

1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible compression type lugs. Reference individual equipment Specification Sections as applicable for additional termination requirements.
2. For conductors with stranding other than Class B or C, a UL 486A Listed wire ferrule shall be installed prior to each conductor termination. Ferrules shall be suitable for the size of conductors and shall be made of a material that is compatible with the conductors. Ferrules shall be crimped on in accordance with the ferrule manufacturer's instructions.
3. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction box per the requirements of Section 26 05 33.16 – Boxes for Electrical Systems, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.
4. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
5. To minimize oxidation and corrosion, selected wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for electrical connections. The compound shall be Penetrox E for copper-to-copper connections, and

Penetrox A for all other connections, as manufactured by Burndy Electrical, or equal. The joint compound shall be used in the following installations:

- a. Termination of aluminum conductors, where aluminum conductors are specifically allowed by the Engineer.
 - b. Terminations in all Class I and Class II, Division 1 and 2 hazardous areas.
6. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the workday for which the cable is removed from the protected storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

I. Circuit Log

1. The Contractor shall maintain a written log of installed circuit lengths for all single-phase and three-phase power circuits operating at 208VAC or greater. The log shall be organized in a tabular format, recording the following items for each circuit:
 - a. Circuit ID or Conduit ID(s) as shown on the Drawings.
 - b. From (originating equipment).
 - c. To (terminating equipment).
 - d. Conductor sizes and counts.
 - e. Conductor length.

3.02 TESTING

- A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 1. Shop Test

- a. Wires and cables shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer's standards.

2. Field Tests

- a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be "test light" or "buzzer" style.
- b. After installation, wires and cables shall be tested for insulation resistance levels between conductors of the same circuit and between conductor and ground as follows:
 - 1) For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute. Resistance shall be no less than 100 Megohms.
 - 2) Instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter or approved equal. The resistance value shall be 200 Megohms or greater.
 - 3) Insulation resistance testing is not required for power and control cables smaller than #8 AWG.
- c. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.
- d. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.
- e. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

**Exhibit A
Test Data – Megohms
Test No. _____**

Date:			Company:				
Time:			Location:				
Circuit:	Circuit Length:	Aerial:	Duct:	Buried:	No. of Conductors	Size:	AWG MCM Shield:
Insulation Material:			Insulation Thickness:		Voltage Rating:		Age:
Type: _____ Pothead _____ Terminal					Location: Indoors _____ Outdoors _____		
Number and Type of Joints:							
Recent Operating History:							
Manufacturer:							
State if Potheads or Terminals were grounded during test:							
List associated equipment included in test:							
Miscellaneous Information:							

Exhibit A
Test Data – Megohms
Test No. _____

Part Tested:	Test Performed: _____ Hours/Days: _____ After Shutdown: _____
Grounding Time:	Dry Bulb Temperature: _____ Wet Bulb Temperature: _____
Test Voltage:	Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____

Megohmmeter: Serial Number: _____ Range: _____
 Voltage: _____ Calibration Date: _____

Test Connections	To Line	To Line	To Line	Test Connections	To Line	To Line	To Line
	To Earth	To Earth	To Earth		To Earth	To Earth	To Earth
	To Ground	To Ground	To Ground		To Ground	To Ground	To Ground
1/4 Minute				5 Minutes			
1/2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minute Ratio			

Remarks:

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install grounding systems complete in accordance with the requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.
- B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.
- C. In addition to the NEC requirements, building structural steel columns shall be permanently and effectively grounded:
- D. Reference Section 26 05 00 – Basic Electrical Requirements

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
 - a. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - b. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 3. Underwriters Laboratories (UL):
 - a. UL 467 – Grounding and Bonding Equipment.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of certified field tests.
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 GROUND RODS AND GRID

- A. Ground rods shall be rolled to a commercially round shape from a welded copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 pounds per square inch (psi) and an elastic limit of 49,000 psi. The rods shall be not less than 3/4 inch in diameter by 10 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of

0.010 inch at any point on the rod. Ground rods shall be UL 467 Listed. The ground rods shall be manufactured by Erico Products, Blackburn, or Engineer approved equal.

- B. Except where specifically indicated otherwise, all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways, and neutral conductors of wiring systems shall be grounded.
- C. The ground connection shall be made at the main service equipment and shall be extended to the ground grid surrounding the structure. The ground grid shall also be connected to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection.
- D. Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

2.03 FITTINGS

- A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 Listed.

2.04 EQUIPMENT GROUNDING CONDUCTORS

- A. An insulated equipment grounding conductor, which shall be separate from the electrical system grounded (neutral) conductor, shall be furnished and installed for all circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.

2.05 EQUIPMENT GROUNDS

- A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.
- B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds, and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

2.06 GROUND BARS

- A. Ground bars shall be furnished and installed where indicated on the Drawings and where required in the Specifications. Ground bars shall be tin-plated copper, 1/4-inch thick (minimum) with hole pairs spaced for NEMA 2-hole cable termination lugs. The number of hole pairs shall be as required for the number of cables terminated, plus four (4) spares (minimum). Ground bars shall be provided with insulated mounting hardware.

2.07 EXOTHERMIC WELDS

- A. All exothermic welding shall be completed per welding kit manufacturer's instructions. Exothermic welds shall be CadWeld by Erico or ThermoWeld.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.
- B. Ground Grid
 1. A main ground grid shall be provided for each structure and interconnecting structure grids consisting of driven ground rods as shown on the Drawings. Ground rods shall be driven straight down into the earth, or if objects are encountered, at an angle to avoid the obstruction.
 2. The ground rods shall be interconnected by the use of copper cable sized as shown on the Drawings. The interconnecting cables shall be connected to ground rods by hydraulic crimp or exothermic weld where buried, and removable bolted clamp where shown to be installed in test wells. The grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtails" shall be connected to the ground grid and shall enter the buildings and structure from the outside, and shall be connected to steel structures, equipment as described in this Section, and as required to provide a complete grounding system. The copper pigtails shall be hydraulically crimped or exothermically welded to the ground grid and connected to building reinforcement steel by hydraulic crimp.
 3. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.

4. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in metal raceway. The raceway shall be bonded to the grounding system.
5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.
6. Buried hydraulic crimp connections, exothermic welds, and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, switchboards, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 1. Witnessed Shop Tests
 - a. None required.
 2. Field Tests
 - a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.
 - b. Fall of potential tests shall be performed on the ground grid per IEEE 81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.

- c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install structural supports for mounting and installing all conduits, electrical equipment, lighting, alarm systems, instrumentation, and control and communications equipment furnished under this Contract.
- B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.
- C. Support design for all nonstructural electrical components (e.g., conduit and other raceways, freestanding equipment, etc.) shall be provided in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.
- D. Reference Specification Section 26 05 00 – Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - c. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - d. ASTM A276 – Standard Specification for Steel Bars and Shapes.
 - e. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts.

2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 1. Shop drawings
 2. Structural support calculations and designs in accordance with the governing Building Code and Section 01 73 23 – Anchorage and Bracing of Nonstructural Components.
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 1. Product data sheets.
 2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS

- A. Support channel shall be 1-5/8" by 1-5/8" minimum, with 12-gauge material thickness.

- B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Material of Construction
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Hot Dipped Galvanized Steel
Indoor Dry Non-process Area	Hot Dipped Galvanized Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

- C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Material of Construction
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Type 304 Stainless Steel
Indoor Dry Non-process Area	Type 304 Stainless Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Concrete or Masonry Inserts
1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.
 2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.

3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.
2. Unless otherwise indicated on the Drawings or in the Specifications, guards/handrails shall not be utilized as supports for electrical equipment, devices, or appurtenances. Guards/handrails shall not be cut, drilled, or otherwise modified in order to accommodate electrical supports without written approval from the Engineer.
3. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars, where possible, to facilitate removal of ceiling panels.
4. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.
5. Equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.
6. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.
7. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.
8. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; Contractor shall submit design details to the Engineer for acceptance before proceeding with the fabrication.
9. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

10. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.
 11. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.
 - a. A quantity of twelve (12) or more conduits trade size 1" and smaller are proposed for a conduit support rack.
 - b. A quantity of eight (8) or more conduits trade sizes 1 1/2" to 2 1/2" are proposed for a conduit support rack.
 - c. A quantity of four (4) or more conduits trade sizes 3" and larger are proposed for a conduit support rack.
 12. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple conduits are installed exposed together, support channel and conduit clamps shall be used.
- C. Equipment, boxes, and enclosures which are factory-constructed with integral mounting provisions (such as brackets, mounting feet, bolt holes, etc.) shall be installed/supported utilizing those mounting provisions. Equipment, boxes and enclosures shall not be field-modified by any means which compromises the UL Listing or NEMA rating of the enclosure/assembly.

END OF SECTION

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SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install conduits, conduit fittings, and appurtenances to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Reference Specification Section 26 05 00 – Basic Electrical Requirements.
- C. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Specification Section 26 05 29 – Hangers and Supports for Electrical Systems, for these requirements.

1.02 CODES AND STANDARDS

- A. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Conduits, conduit fittings, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI/ASME B1.20.1 – Pipe Threads, General Purpose.
 - b. ANSI C80.1 – Electrical Rigid Steel Conduit.
 - c. ANSI C80.3 – Steel Electrical Metallic Tubing.
 - d. ANSI C80.5 – Electrical Rigid Aluminum Conduit.
 - e. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
 - 2. National Electrical Contractors Association (NECA):
 - a. NECA 1 – Standard for Good Workmanship in Electrical Construction.
 - 3. National Electrical Manufacturer's Association (NEMA):
 - a. NEMA FB 2.40 – Installation Guidelines for Expansion and Expansion/Deflection Fittings.

- b. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit.
 - c. NEMA RV-3 – Application and Installation Guidelines for Flexible and Liquid-tight Flexible Metal and Nonmetallic Conduits.
 - d. NEMA TC-2 – Electrical PVC Conduit.
 - e. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.
4. National Fire Protection Association (NFPA):
- a. NFPA 70 – National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
- a. UL 1 – Standard for Flexible Metal Conduit.
 - b. UL 6 – Electrical Rigid Metal Conduit-Steel.
 - c. UL 6A – Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel.
 - d. UL 360 – Standard for Liquid-tight Flexible Metal Conduit.
 - e. UL 467 – Grounding and Bonding Equipment.
 - f. UL 514B – Conduit, Tubing, and Cable Fittings.
 - g. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings.
 - h. UL 797 – Electrical Metallic Tubing-Steel.
 - i. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - j. UL 1479 – Standard for Fire Tests of Penetration Fire Stops.
 - k. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit.
6. Others:
- a. American Concrete Institute (ACI): ACI 318 – Building Code Requirements for Structural Concrete.
 - b. Aluminum Association – Aluminum and It's Alloys.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Conduit identification methods and materials.
 - 2. Product data sheets for conduits, fittings, and miscellaneous associated materials.
 - a. The product data sheets for conduits and fittings for up to three (3) manufacturers for each type of conduit specified herein will be reviewed if they are submitted at the same time under the same submittal cover for simultaneous review.
 - b. Despite the number of manufacturers that may be approved, only one manufacturer of PVC coated rigid metal conduit will be permitted to be installed on this project in accordance with the requirements set forth in Part 3 herein.
 - 3. Manufacturer's Warranty Statement for PVC coated rigid metal conduit.
 - 4. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

1.05 DEFINITIONS

- A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:
 - 1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.

2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Also, conduits that carry fiber optic cables between devices and/or equipment.
3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment. Conduits that carry Category 5e or Category 6 unshielded twisted-pair cables.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses, and installation requirements of these conduits and conduit fittings.
- B. All metallic conduit fittings shall be UL 514B and UL 467 Listed and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I, Division 1 hazardous areas shall be UL 1203 Listed with a visible certification tag on the outside of the fitting. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.
- C. Flexible conduit couplings for use in Class I, Division 1 hazardous areas shall have threaded Type 316 stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of Type 316 stainless steel where available in the conduit trade size required for the application. Where Type 316 stainless steel braid is not available, the braid shall be provided with a factory-applied PVC coating. No other braid types or materials are acceptable.
- D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.
- E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.
- F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to $\frac{3}{4}$ inch of expansion/contraction along the axis of the conduit as well as up to $\frac{3}{4}$ inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by Type 304 stainless steel clamps.
- G. Conduit seals shall either be Listed and Labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within

the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.

- H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.
- I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

2.02 RIGID GALVANIZED STEEL (RGS) CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

- 1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.
- 2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Galvanized Steel

- 1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
- 2. Conduit bodies for Class I, Division 1 hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.
- 3. Conduit bodies for all other areas shall be provided with covers that are affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

- 1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of Type 316 stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.
3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.
2. Conduit body shall be provided with cover that is affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that

utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.
3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.
2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.
3. PVC coated conduit and associated PVC coated fittings shall be Ocal-Blue by ABB, Plasti-Bond by Robroy Industries, or Perma-Cote by Robroy Industries, no substitutions.
4. PVC coated conduit and associated PVC coated fittings shall be provided with a 5-year non-prorated warranty covering manufacturing defects and improper installation by the Contractor.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.
3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN 1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I, Division 1 hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.
3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by Type 304 stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

G. Conduit Termination Fittings for Use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 RIGID ALUMINUM CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be made of heavy wall high strength 6063 alloy aluminum with temper designation T1 as defined by the Aluminum Association. Conduit shall be manufactured in accordance with ANSI C80.5 and shall be UL 6A Listed.
2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Aluminum Conduit

1. Conduit bodies shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I, Division 1 hazardous areas shall be provided with integrally threaded covers constructed of copper-free aluminum which is coated with an aluminum enamel finish.
3. Conduit bodies for all other areas shall be provided with stamped copper-free aluminum covers that are affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Aluminum Conduit

1. Couplings and nipples shall be threaded and shall be constructed of heavy wall high strength 6063 alloy aluminum with temper designation T1. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of copper-free aluminum which is coated with an aluminum enamel finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Aluminum Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Aluminum Conduit

1. Conduit seals shall be constructed of copper-free aluminum which is coated with an aluminum enamel finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Aluminum Conduit

1. Conduit hubs shall be constructed of copper-free aluminum and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of copper-free aluminum. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.

3. Conduit bonding bushings shall be constructed of copper-free aluminum. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.06 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.
2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed. Conduits shall be Listed for and marked with maximum temperature ratings as follows:
 - a. 105 degrees C dry, 60 degrees C wet for all conduit installed against or within 2 inches of equipment capable of having a surface temperature of 80 degrees C or greater (e.g., blowers, incinerators, etc.)
 - b. 80 degrees C dry, 60 degrees C wet for all other locations

B. Conduit Termination Fittings for use with LFMC

1. Conduit termination fittings shall be constructed of either Type 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.
2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

2.07 LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC), fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1660 Listed and be Type LFNC-B.

B. Conduit Termination Fittings for use with LFNC

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

2.08 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

B. Conduit Termination Fittings for use with FMC

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-style connection to the associated conduit.

2.09 ELECTRICAL METALLIC TUBING (EMT) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be hot dipped galvanized on the inside and outside and made of cold-rolled steel tubing. Conduit shall be manufactured in accordance with C80.3 and shall be UL 797 Listed.

B. Conduit Bodies for use with EMT

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies shall be provided with galvanized sheet steel covers that are affixed in place by Type 304 stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to

the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Nipples for use with EMT

1. Couplings and nipples shall have threaded compression connectors with associated gland and shall be constructed of electro-galvanized steel. Fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable. Couplings and nipples shall be rain-tight and have a plastic insulated throat.

D. Conduit Expansion and Deflection Fittings for use with EMT

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Termination Fittings for use with EMT

1. Conduit termination fittings shall be constructed of electro-galvanized steel and have a plastic insulated throat. Termination fittings shall have a threaded compression connector with associated gland on one end and external threads on the other end. Termination fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts shall have integral bonding screw where required for proper bonding.

2.10 CONDUIT BENDS

- A. Rigid conduit bends, both factory-fabricated and field-fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

- B. Conduit bend radii for standard radius bends shall be no less than as follows:

Trade Size (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
Min. Radius (inches)	4-1/2	5-3/4	7-1/4	8-1/4	9-1/2	10-1/2	13	15	16	24	30

- C. Conduit bend radii for long radius bends shall be no less than as follows:

Trade Size (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
Min. Radius (inches)	N/A	12	18	24	30	30	36	36	48	48	60

2.11 MISCELLANEOUS

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:
 - a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.
 - b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors.
 - c. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.
2. See Part 3 herein for the specific application of the conduit periphery sealing requirements above that are to be used based on what the conduit will be penetrating.

B. Primer and Cement

1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer's recommended cement that is labeled Low VOC.

C. Galvanizing Compounds

1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.

D. Conduit Interior Sealing

1. For all conduits that have cables inside, the sealing of the inside of the conduits against water ingress shall be achieved through the use of one of the following:
 - a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit.

Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.

- b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Rayflite by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.
 - c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed by two Type 304 stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.
- 2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.
 - 3. For conduits identified as spares, the sealing of the inside of the conduit against water ingress shall be achieved by using appropriately sized rubber expanding-style conduit plugs.

E. Pull Rope

- 1. Pull ropes for empty and/or spare conduits shall be woven polyester, ½-inch wide, with a minimum tensile strength of 1250 lbs. In addition, pull ropes for conduits that are installed concealed shall also have a 22-AWG (minimum) tin-plated copper conductor woven in to make the rope detectable.
- 2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull and shall be made of a non-metallic material.

PART 3 – EXECUTION

3.01 GENERAL

- A. All conduit and associated fittings and appurtenances shall be installed in accordance with NECA 1.
- B. Minimum trade size for all rigid conduits shall be 1 inch if any portion of the conduit is installed in a ductbank and ¾ inch for all other applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the

Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.

- C. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.
- D. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.
- E. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.
- F. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.
- G. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be 3/4 inch per foot tapered threads in accordance with ANSI B1.20.1.
- H. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.
- I. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.
- J. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:

Installation Scenario	Clearance
Parallel to conduits with conductors energized at 480V or above	18 inches
Parallel to conduits with conductors energized at 240V and below	12 inches
At right angles to conductors energized at 480V and below	6 inches
At right angles to conductors energized at voltages above 480V	12 inches

- K. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.

- L. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.
- M. Conduits shall not penetrate the floors or walls inside liquid spill containment areas without specific written authorization from the Engineer. Liquid spill containment areas are indicated on the Drawings.
- N. Conduits shall only penetrate the walls of liquid-holding tanks or basins above the maximum liquid elevation. Conduits shall not penetrate walls below this elevation. Maximum liquid elevations are indicated on the Drawings.
- O. Conduits that terminate at roof mounted equipment shall be installed through the roof curb for the associated equipment to avoid additional roof penetrations wherever possible. Conduits that are installed horizontally on roof surfaces shall be supported by roof blocks that do not impact the roof manufacturer's warranty and shall be installed at least 7/8 inch above the roof surface to avoid the need to further de-rate the conductors inside.
- P. In no case shall conduit be supported or fastened to another pipe or be installed in a manner that would prevent the removal of other pipes for repairs. Spring steel fasteners may only be used to affix conduits containing lighting branch circuits within EMT conduits to structural steel members.
- Q. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.
- R. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.
- S. If multiple manufacturers of PVC coated conduit and conduit fittings are reviewed and approved for use by the Engineer, only one manufacturer shall be permitted to be used on the project throughout the entirety of the project. Consistency of a single manufacturer is critical to ensure proper fit and alignment, and to maintain the manufacturer's warranty throughout the PVC coated system. Use of multiple manufacturers' PVC coated products is not acceptable.
- T. Conduits which emerge from within or below concrete encasement shall be PVC coated rigid galvanized steel in accordance with Standard Detail E-26-0102 where the conduit is not protected by an equipment enclosure that surrounds the conduit on all sides at the point where it emerges from the encasement.
- U. Aluminum conduits shall not be installed in direct contact with concrete surfaces. Where aluminum conduits are routed along concrete surfaces, they shall be installed with one-hole electro-galvanized malleable iron alloy straps with matching clamp-backs to space

the conduit ¼ inch away from concrete surface. Where aluminum conduit passes through concrete, CMU or brick walls, the penetration shall be made such that the aluminum conduit does not come in contact with concrete, CMU, brick or mortar.

3.02 CONCEALED AND EMBEDDED CONDUITS

- A. Conduits are permitted to be installed concealed and/or embedded with the following requirements:
1. Conduits shall not be installed horizontally when concealed within CMU walls, only vertical installation is acceptable.
 2. Conduits installed embedded within concrete floors or walls shall be located so as not to affect the designed structural strength of the floor or wall. Embedded conduits shall be installed in accordance with Standard Detail S-03-0403 and ACI 318.
 3. Where conduit bends emerge from concrete embedment, none of the curved portion of the bend shall be visible. Only the straight portion of the bend shall be visible. The straight portion shall emerge perpendicular to the embedment (i.e., neatly oriented 90-degrees to floor/slab/grade). Conduits that emerge in a non-perpendicular orientation are not acceptable.
 4. Where multiple conduits emerge from concrete embedment or from concealment below a concrete floor, ample clear space shall be provided between conduits to allow for the appropriate and required conduit termination fittings to be installed.
 5. Conduits installed embedded within concrete encasement of any kind shall be installed such that conduit couplings for parallel conduits are staggered so that they are not side by side.
- B. Conduits are NOT permitted to be installed concealed and/or embedded for the following situations:
1. Conduits shall not be installed embedded within any water-bearing floors or walls.
 2. Conduits shall not be installed embedded within any liquid containment area floors or walls.
 3. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to Class I and II hazardous areas (Division 1 and Division 2).
 4. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to indoor Type 1 or Type 2 chemical storage/transfer areas.

3.03 CONDUIT USES AND APPLICATIONS

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

Rigid Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry process areas	Rigid aluminum conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Rigid aluminum conduit	Same as Power and Control
Exposed in indoor Type 1 chemical storage/transfer areas	Schedule 80 rigid non-metallic PVC conduit	Same as Power and Control
Exposed in indoor Type 2 chemical storage/transfer areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed in outdoor areas	Rigid aluminum conduit	Same as Power and Control
Exposed within pre-fabricated electrical equipment center buildings	Electrical Metallic Tubing	Same as Power and Control
Concealed within underground concrete-encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Direct-buried conduits (where specifically permitted)	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within non-elevated (i.e., "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within elevated concrete slabs	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid galvanized steel conduit
Concealed below concrete slabs (within earth or fill material)	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid galvanized steel conduit
Concealed within concrete walls	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid galvanized steel conduit

Rigid Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Concealed within CMU walls	Schedule 40 rigid non-metallic PVC conduit or Electrical Metallic Tubing	Rigid galvanized steel conduit
Concealed above suspended ceilings	Electrical Metallic Tubing	Same as Power and Control
Concealed within interior walls constructed of metal studs and gypsum wall board	Electrical Metallic Tubing	Same as Power and Control
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit (Reference Detail E-26-0102)	Rigid galvanized steel conduit	Same as Power and Control

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

Rigid Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in Class I and II areas (Division 1 and Division 2)	Rigid Galvanized Steel Conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material) in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete walls in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I, Division 1 areas	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

Rigid Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Concealed above suspended ceilings in Class I and II areas (Division 1 and Division 2)	Rigid Galvanized Steel Conduit	Same as Power and Control

3. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:
 - a. All 90-degree bends or combinations of adjacent bends that form a 90-degree bend where concealed within concrete or below a concrete slab shall be rigid galvanized steel.
2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.
3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.
4. Long radius bends shall be furnished and installed for the following specific applications, all other bends shall be standard radius:
 - a. All conduits containing medium voltage cable.
 - b. All conduits containing fiber optic cable.
 - c. All conduits containing shielded VFD cable.
 - d. Where specifically indicated on the Drawings.

C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:
 - a. Connections to motors and engine-generator sets (and similar vibrating equipment)
 - b. Connections to solenoid valves and limit switches
 - c. Connections to lighting fixtures installed in suspended ceilings
 - d. Connections to lighting transformers and combination power units
 - e. Connections to pre-fabricated equipment skids
 - f. Connections to HVAC equipment
 - g. Connections to instrument transmitters and elements
 - h. Where specifically indicated in the Standard Details
2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.
3. Unless otherwise specified herein, flexible conduits shall be installed in accordance with the Installation Guidelines published within NEMA RV-3.
4. Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

Flexible Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry process areas	Flexible metal conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Flexible metal conduit	Same as Power and Control
Exposed in indoor Type 1 chemical storage/transfer areas	Liquid-tight flexible non-metallic conduit	Same as Power and Control

Flexible Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor Type 2 chemical storage/transfer areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in outdoor areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings (all indoor areas)	Same material as exposed conduit in same area	Same as Power and Control

- For Class I, Division 1 hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings shall be installed as specified in Part 2 herein. Flexible conduit for all other hazardous areas shall be furnished and installed in the materials of construction as follows:

Flexible Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in Class I, Division 2 areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in Class II (Division 1 and Division 2) areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings in Class I (Division 2) and Class II (Division 1 and Division 2) areas	Same material as exposed conduit in same area	Same as Power and Control

3.04 CONDUIT FITTING USES AND APPLICATIONS

A. General

- Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.
- Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.
2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than $\frac{1}{4}$ inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.
2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.
3. Unless otherwise specified herein, conduit expansion and deflection fittings shall be installed in accordance with the Installation Guidelines published within NEMA FB 2.40.

E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC. In addition, conduit seals shall also be furnished and installed as follows:
 - a. All conduits entering or leaving enclosed areas which store or distribute chlorine gas.
 - b. All conduits entering or leaving enclosed areas which store or distribute sulfur dioxide gas.

F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.
2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the interior locknut.
3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

3.05 MISCELLANEOUS

A. Conduit Periphery Sealing

1. Unless otherwise indicated on the Drawings, below-grade conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein.
2. Unless otherwise indicated on the Drawings, all conduit penetrations through interior walls and floors and above-grade exterior walls shall be sealed using conduit sleeves and caulk as specified in Part 2 herein. Alternatively, where concrete or masonry walls/floors are penetrated, mortar may be used to seal around the conduit periphery for conduit penetrations through interior walls and floors and above-grade exterior walls.
3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

B. Conduit Interior Sealing

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

2. Conduit interior sealing shall not be installed until conductors inside are tested and test results are deemed acceptable by the Engineer. Conduit interior sealing shall be installed prior to energization of the conductors inside.

3.06 CONDUIT IDENTIFICATION

- A. The identification system for the conduits furnished and installed under this Contract shall match the existing identification system used at the project location.

3.07 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

3.08 TRAINING OF INSTALLATION PERSONNEL

- A. All Contractor personnel that install PVC coated rigid metal conduit shall be trained by the PVC coated conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit or shall be trained/re-trained as required prior to commencement of conduit installation.

END OF SECTION

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all pull boxes, junction boxes, and outlet boxes as specified herein, indicated on the Drawings, and as required. Requirements for other boxes and enclosures are not necessarily included in this Section. Reference each specific equipment specification section for requirements related to that equipment's respective enclosure.
- B. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 33.13 – Conduit for Electrical Systems
 - 3. Section 26 05 53 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

- A. All boxes shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Boxes shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 – Enclosures for Electrical Equipment.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 3. Underwriters Laboratories (UL):
 - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.
 - b. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations.
 - c. UL 514A – Metallic Outlet Boxes.

- d. UL 514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.
- e. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:
 - 1. Shop Drawings
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets for boxes, terminal strips, and all accessories
 - 2. Overall bill of material for all boxes included under this Contract to summarize exactly what is being submitted for review. Bill of material shall at a minimum show each box type (i.e., pull, junction, or outlet), quantity, material of construction, dimensions, and proposed installation location.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.
- B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

1.06 IDENTIFICATION

- A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g., PPB-XXX, CJB-YYY) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 PULL AND JUNCTION BOXES

A. General

1. All pull and junction boxes shall be UL Listed and Labeled.
2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.
3. Pull and junction boxes mounted embedded in concrete shall be UL Listed for embedment.
4. Where metallic boxes are used, they shall be of all welded construction. Tack welded boxes are not acceptable.

B. Pull Boxes

1. Metallic pull boxes in non-hazardous locations and in hazardous locations where general-purpose enclosures are permitted (e.g., Class I, Division 2 locations) shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.
2. Metallic pull boxes in hazardous locations where general-purpose enclosures are not permitted (e.g., Class I, Division 1 locations) shall be provided with a matching gasketed cover. Cover shall be hinged and held in place by stainless steel bolts. Hinge pins shall be removable. Covers shall be installed and bolts torqued in accordance with manufacturer requirements to maintain the hazardous location rating of the enclosure.
3. Non-metallic pull boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., “flip”) latches. Latch material of construction shall match the box material, and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.

4. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.
5. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.
6. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:
 - a. Power wiring
 - b. AC control wiring
 - c. DC control wiring
 - d. Instrumentation wiring

C. Junction Boxes

1. Metallic junction boxes in non-hazardous locations shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.
2. Metallic junction boxes in hazardous locations shall be provided with a matching gasketed cover. Cover shall be hinged and held in place by stainless steel bolts. Hinge pins shall be removable. Covers shall be installed and bolts torqued in accordance with manufacturer requirements to maintain the hazardous location rating of the enclosure.
3. Non-metallic junction boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., "flip") latches. Latch material of construction shall match the box material and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.
4. Barriers shall be provided in junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction

shall match that of the box. Isolation shall be provided between the following groups:

- a. Power wiring
 - b. AC control wiring
 - c. DC control wiring
 - d. Instrumentation wiring
5. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.
 6. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting of the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.
 7. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

D. Enclosure Types and Materials

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or PVC

Area Designation	Enclosure Type and Material
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

- In hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 4X, Type 304 Stainless Steel

- Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.
- Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.

2.03 OUTLET BOXES

A. General

- Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 26 27 26 – Wiring Devices for outlet box trim requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

B. Surface Mount Outlet Boxes

- Outlet boxes shall be the deep type, no less than 2.5 inches deep.
- Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.
- In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Cast Aluminum
Indoor Dry Process Area	NEMA 1, Cast Aluminum
Indoor Dry Non-process Area	NEMA 1, Cast Aluminum
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, PVC
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Cast Aluminum
All Outdoor Areas	NEMA 4X, Cast Aluminum

4. In hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 4X, Cast Aluminum

5. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

C. Flush Mount Outlet Boxes

- Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL Listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.
- Outlet boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.
- Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.
- Outlet boxes mounted cast into concrete shall be concrete tight and made of galvanized steel or PVC.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.
4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Reference Section 26 05 33.13 – Conduit for Electrical Systems for conduit hub requirements.
5. Pull and junction boxes may be installed flush mounted in gypsum, concrete, or CMU walls where appropriate provided that covers are easily removed or opened.
6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. Outlet Boxes

1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.
2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.
3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.
4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in hazardous areas and type 1 or 2 chemical storage/transfer areas.
5. Depending on the type of wiring device to be installed in the outlet box, mounting heights from the finished floor or finished grade (as applicable) to the center of the

box shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):

- a. Light switches 48 inches
 - b. Receptacles in indoor dry process/non-process areas, 18 inches
 - c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 42 inches in open areas, or 6 inches (minimum) above adjacent surfaces (e.g., countertops, tables, etc.) where applicable
 - d. Receptacles in outdoor locations, 26 inches
 - e. Flush mounted outlet boxes in CMU walls shall be adjusted to a slightly greater height than required above to align the center of the box with the center of the CMU block.
6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

END OF SECTION

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SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All electrical equipment shall be identified in the manner described, or in an equally approved manner.
- B. The types of electrical identification specified in this Section include, but are not limited to, the following:
 - 1. Operational instructions and warnings.
 - 2. Danger signs.
 - 3. Equipment/system identification signs.
 - 4. Nameplates.

1.02 SIGNS

- A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

1.03 LETTERING AND GRAPHICS

- A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

1.05 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 NAMEPLATES

- A. Nameplates shall be engraved, high pressure plastic laminate, white foreground with black lettering.
- B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or Engineer approved equal.

2.03 HIGH VOLTAGE SIGNS

- A. Standard "DANGER" signs shall be of baked enamel finish on 20 gauge steel; of standard red, black, and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

2.04 CONDUIT IDENTIFICATION

- A. Conduit identification shall be as specified in Section 26 05 33.13 – Conduit for Electrical Systems.

2.05 WIRE AND CABLE IDENTIFICATION

- A. Field installed wire and cable identification shall be as specified in Section 26 05 19 – Low Voltage Conductors and Cable .
- B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly convey the conductor identification means used at that piece of equipment (i.e., Phase A=Brown, Phase B=Orange, C = Yellow).
- C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective Section.

2.06 BOX IDENTIFICATION

- A. Pull, junction and device box identification shall be as specified in Section 26 05 33.16 – Boxes for Electrical Systems.

PART 3 – EXECUTION

3.01 NAMEPLATES

- A. Nameplates shall be attached to the equipment enclosures with two (2) stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

3.03 POWER SOURCE IDENTIFICATION

- A. After installation of all field equipment (e.g., valves, motors, fans, unit heaters, instruments, etc.) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC

number, panelboard, etc.), circuit number, conduit number from schedule and voltage/phase.

- B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.
- C. Nameplates shall be as specified herein.

END OF SECTION

SECTION 26 05 60
LOW-VOLTAGE ELECTRIC MOTORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all low voltage electric motors as shown on the Drawings and specified herein. All motors required for this Contract shall comply with this Section unless otherwise noted.

1.02 CODES AND STANDARDS

- A. Motors and related accessories shall be designed, manufactured, and/or listed to the following standards as applicable:
1. Institute of Electrical and Electronics Engineers (IEEE)
 - a. IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators
 2. National Electrical Manufacturer's Association (NEMA)
 - a. NEMA MG 1 – Motors and Generators
 3. Underwriters Laboratories (UL)
 - a. UL 547 – Standard for Safety Thermal Protectors for Motors
 - b. UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations
 - c. UL 1004-1 – Standard for Rotating Electrical Machines
 - d. UL 1004-3 – Standard for Thermally Protected Motors
 - e. UL 1004-8 – Standard for Inverter Duty Motors

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
1. Shop Drawings.
 2. Spare Parts List.

- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Individual shop drawings for electric motors shall be submitted in accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, unless submitted as a part of the shop drawings for the driven equipment.
- D. Shop drawings for electric motors shall include motor data sheets, dimensioned drawings, wiring diagrams for devices such as space heaters, temperature devices, and shaft grounding rings. Shop drawings shall identify electric characteristics and design, mechanical construction, manufacturer's name, type and pertinent specifications for the use intended, along with the name of the equipment to be driven. For motors rated 50 horsepower or greater, submittal of motor data for acceptance shall include, as a minimum, the following:
 - 1. Manufacturer's type and frame designation
 - 2. Horsepower rating
 - 3. Time rating (per NEMA Standards)
 - 4. Ambient temperature rating
 - 5. Motor winding insulation system designation
 - 6. RPM at rated load
 - 7. Frequency
 - 8. Number of phases
 - 9. Rated-load amperes
 - 10. Voltage
 - 11. Code letter (starting KVA per horsepower)
 - 12. Design letter for integral horsepower induction motors (per NEMA Standards)
 - 13. Service factor

14. Temperature rise at full load and at service factor load
15. Efficiency at 1/4, 1/2, 3/4 and full load
16. Power factor at 1/4, 1/2, 3/4 and full load
17. Motor outline, dimensions and weight
18. Motor winding insulation system description
19. Horsepower required by connected machine at specified conditions (load curves) shall be supplied for all compressors, propeller and positive displacement pumps.
20. The foregoing data shall also be verified after manufacture and shall be included with the information to be furnished in the operation and maintenance manuals specified.

- E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Electric motors shall be manufactured by Baldor/Reliance Electric Company; Nidec Motors; Toshiba Industrial and Power Systems, Inc.; Siemens Energy & Automation, Inc.; General Electric Company; or equal.

2.02 MATERIALS AND CONSTRUCTION

- A. Motors shall be built in accordance with the latest standards of NEMA, including, but not limited to MG-1 and MG-2, IEEE, ANSI and to the requirements specified herein.
- B. Type

1. Unless otherwise noted, motors specified herein shall be polyphase squirrel cage, NEMA Design B, or single phase capacitor or repulsion start induction motors. Special equipment requiring a motor drive with unusual characteristics shall be equipped with a definite purpose motor to meet the necessary requirements.
2. Unless otherwise shown or specified, all motors 1/2 horsepower or larger shall be three- phase, 60 Hertz, NEMA Design B, squirrel cage induction motors designed for operation at 480 volts or greater as specified herein or shown on the Drawings.
3. Unless otherwise specified in the individual equipment specification for the driven equipment, or as required by the dynamic characteristics of the load as determined by the manufacturer of the machine to be driven, all polyphase squirrel cage motors shall be designed to withstand the starting voltage shown on the Drawings and shall have torque and locked rotor current characteristics as specified for NEMA Design B motors.
4. All motors 2 horsepower and smaller shall have windings encapsulated with a flexible epoxy compound, or insulated with a flexible epoxy compound, or insulated with the manufacturer's premium quality system which shall be subject to acceptance by the Engineer.
5. All motors above 250 horsepower shall have stator windings vacuum impregnated with a polyester insulation compound.
6. Unless otherwise noted, all motors smaller than 1/2 horsepower shall be standard single-phase capacitor start or repulsion start induction type designed for operation on 120 volts or 208 volts, 60 Hz alternating current. The motor shall deliver rated load without exceeding a 80 degrees C temperature rise while operating in a 40 degrees C ambient temperature. Small fan motors less than 1/4 HP may be split-phase or shaded pole type. Shaded pole motors rated more than 1/4 horsepower are not acceptable. Fractional horsepower motors shall be completely equipped with all necessary auxiliary components for starting and labeled as "Thermally Protected". Insulation shall be Class B, except that submersible motors shall have epoxy encapsulation. Unless otherwise noted, the motors shall be totally enclosed. Small fan motors may be of the open type where they are suitably protected from moisture dripping and lint accumulation. Motors shall be provided with sealed ball bearings lubricated for 10 years of normal use.
7. Where specified, vertical hollowshaft motors shall be designed to carry the motors', pumps', and associated equipment's full thrust. The motors shall be equipped with grease lubricated spherical roller thrust bearings and lower radial guide bearings. Vertical hollowshaft motors shall be fitted with nonreversing ratchet assemblies where required by equipment specifications. Vertical adjustment shall be provided by means of a lockable nut at the top of the shaft.

8. Vertical hollowshaft motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Horizontal motors shall not be installed where subjected to external thrust loads.

C. Rating

1. Each motor shall develop ample torque for its required service through its acceleration range and throughout its rated load range. The rating of the motors offered shall in no case be less than the horsepower shown on the Drawings or elsewhere specified. It should be noted that the motor sizes indicated on the Drawings or as otherwise specified herein, are motor sizes required to operate the specific equipment which is specified. Higher rated motor sizes may be determined from the actual equipment submitted, approved, purchased, and installed. Protective devices, motor starters, disconnect switches, and other necessary equipment shall be furnished and installed for the actual motor sizes required at no additional cost.
2. Motor ratings shall be based on continuous operation. The maximum temperature rise for open and drip proof type motors shall not exceed 90 degrees C, and for totally enclosed type motors shall not exceed 80 degrees C.

D. Motor Winding Insulation

1. Insulation shall be as specified for each particular type or class of motor. The insulation system shall provide a high dielectric strength, long life covering for the windings which may be required to operate in a continually damp, corrosive, and/or chemically contaminated environment. The insulation shall be resistant to attack by moisture, acids, alkalies, abrasives, and mechanical and thermal shock. Leads shall be sealed with a non-wicking, non-hydroscopic insulation material.
2. Motor insulation resistance may be checked at any time after delivery to the job site or during the warranty period. Encapsulated motor stators may be subjected to insulation testing while completely submerged in water. Any motor not meeting the requirements specified herein will be rejected and shall be promptly replaced at no cost to the Owner.
3. Torque and locked rotor current characteristics for three phase motors shall be NEMA Design B. The locked rotor KVA/HP input at full voltage for 10 horsepower. motors and larger shall not exceed that permitted for Code Letter "J", except for specialized equipment requiring a motor drive with special definite characteristics.
4. Unless otherwise specified, non-inverter duty motors shall be furnished with a Class F insulation system. Unless otherwise specified, inverter duty motors shall be furnished with a Class H insulation system. In either case, temperature rise shall be limited to that for Class B insulation. Output torque and speed characteristics of each motor shall be suitable to operate the driven equipment through the full range of acceleration and operating load conditions without exceeding the nameplate current rating, and/or temperature rise.

E. Nameplates

1. The motor manufacturer's nameplate shall be engraved, embossed, or stamped on a stainless steel sheet and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Printed or laser-etched nameplates are not acceptable.
2. Nameplates shall include as a minimum, Items 1 through 14 as listed in Article 1.04 D in addition to that required by NEMA standards. The nameplate shall be positioned so as to be readily visible for inspection as installed in the facility.

F. Design

1. Motors shall be designed to accelerate and drive the connected equipment under all normal operating conditions without exceeding nameplate ratings.
2. Motors specified for operation with variable frequency drives shall be inverter duty rated. Motors shall be considered inverter duty rated only if they meet all of the requirements for NEMA MG-1 Part 31.
3. Motors shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished. Inverter duty motors shall be designed to operate down to 10% of full load speed without the need for a line powered cooling fan.
4. Unless otherwise specified, electric motors shall be furnished with service factors in accordance with NEMA MG-1 as follows:

Type of Motor	Service Factor
Non-inverter Duty	1.15
Inverter Duty	1.0

5. Design selection with respect to the driven machine shall be such that the requirements do not exceed 85 percent of the motors' maximum rating modified by service factor, ambient temperature, enclosure, altitude and electrical service. The electrical service conditions shall be assumed to be 10 percent undervoltage, 5 percent underfrequency, and 3 percent voltage unbalance. Altitude shall be assumed to be the project site elevation plus 10 percent. Ambient temperature shall be assumed to be 95 degrees F in exterior locations, 104 degrees F (40 degrees C) in interior locations, and 122 degrees F (50 degrees C) within housings or enclosures; except where higher temperatures may be encountered within or on individual items of equipment. The applicable paragraphs of NEMA MG-1 shall be used in making the design selection.
6. Motors used with belt drives shall have sliding bases to provide for belt take up.

7. Terminal boxes shall be of sufficient size to accommodate the required quantity and size of conduits. Gasketed terminal boxes shall be furnished with all splash-proof and totally enclosed motors. NEMA ratings of the terminal boxes shall be suited for the application. Motors located in hazardous locations shall be furnished with terminal boxes suitable for the specific Class, Division, and Group suitable for the application. Terminal boxes shall be sized to accommodate accessory equipment such as motor differential current transformers, where required.
8. Terminal boxes for horizontal motors shall be located on the left-hand side when viewing the motor from the drive shaft end and shall be so designed that conduit entrance can be made from above, below, or either side of the terminal box.
9. Motors larger than 250hp shall be manufactured with the six stator coil leads wired to a suitably sized motor junction box for application in a differential relay scheme. Current transformers shall be provided by the motor manufacturer and installed in the factory. All ground connections and current transformer connections shall be made in the factory.

G. Construction

1. Frames, mounting means, and shafts shall meet NEMA Standards for the horsepower, RPM, and enclosure selected. Enclosures shall be selected according to the degree of mechanical protection required and shall not be of aluminum construction. All motors shall have a manufacturer's standard shop machinery finish, consisting of a rust resisting priming coat of zinc chromate and a finish coat of alkyd machinery enamel.
2. Motors shall have cast iron frames and a heavy gauge steel terminal box, with neoprene gaskets between the frame and the box and between the box and its cover. A grounding lug(s) shall be provided inside the terminal box.
3. Motors weighing more than 50 pounds shall be equipped with at least one lifting eye. All lifting hardware shall be corrosion resistant.
4. Motors located in hazardous locations shall be totally enclosed and suitable for the specific Class, Division, and Group suitable for the application.
5. Motors located in Class I or II, Division 1 hazardous locations shall bear a U.L.-674 label and shall be provided with a breather/drain approved for the hazardous location. The U.L. listed breather/drain shall prevent the entrance of contaminants while allowing moisture to drain out of the motor.
6. When located outdoors, or elsewhere if specified, motors shall be totally enclosed, nonventilated (TENV) or totally enclosed, fan cooled (TEFC) machines, unless otherwise noted. Totally enclosed motors shall be provided with two (2) 1/4 inch drain holes drilled through the bottom of the frame, which allows complete drainage of the frame. Where specified, TEFC motors controlled by a variable

frequency drive shall be provided with a separately powered cooling fan motor that runs at 60HZ to ensure proper cooling of the motor at low speeds. Cooling fan motor shall be suitable for 120VAC, single phase operation. Vertically oriented motors located outdoors shall be provided with a drip cover over the fan end to prevent accumulation of precipitation.

7. Unless otherwise specified, motors rated 100 horsepower or greater located outdoors, in unheated structures, in below grade areas, or as otherwise indicated, shall be furnished with space heaters and embedded motor winding high temperature switches with leads brought out of the motor terminal box. Space heaters shall be suitable for 120VAC operation and for a maximum surface temperature of less than 200 degrees C. Space heaters shall be of sufficient wattage to maintain the internal temperature of the motor at approximately 10 degrees C above the ambient temperature when the motor is not running.
 - a. Embedded motor winding temperature switches shall operate at temperatures well below the temperature rating of the motor winding insulation system. Motor winding temperature switches are not required where other temperature monitoring devices (e.g. RTD's) are required.
8. Unless otherwise specified in the equipment specifications, motors rated 200HP or greater that are controlled by a VFD shall be furnished with resistance thermal detectors (RTD's) embedded in the stator windings, two per phase. RTD's shall be pre-wired to terminal blocks located in a separate terminal box as specified herein.
9. Unless otherwise specified in the equipment specifications, motors rated less than 200HP that are controlled by a VFD shall be furnished with motor winding high temperature switches embedded in the stator windings with the leads brought out to the motor terminal box.
10. If so specified and when located in indoor areas which are heated and weatherproof, motors shall be open drip-proof machines. Ventilation openings shall be arranged to prevent the entrance of drops of liquid or solid particles at any angle from zero to 15 degrees downward from vertical.
11. Unless otherwise specified, or required, motors rated less than 200 horsepower shall be furnished with bearings of the grease lubricated, antifriction ball type with conveniently located grease fittings and drain plugs. A means of preventing bearings from becoming over-greased shall be provided. Bearings shall have a minimum B-10 life of 20,000 hours.
12. Rotors shall be statically and dynamically balanced. Rotor windings shall be one-piece cast aluminum. Where applicable, rotors shall be constructed with integral fins.
13. Externally mounted motor shaft grounding rings shall be provided to protect motors against motor shaft and bearing currents. Grounding rings shall be provided for all motors controlled by VFDs, with the following exceptions:

- a. Motors located in hazardous areas
 - b. Motors rated less than 1 horsepower
 - c. Submersible motors
14. All motors shall be provided with factory-installed one-hole terminations (ring terminals) on the ends of all motor leads. Terminations shall be identified for use with cables that have stranding other than Class B and shall be the irreversible compression type.

H. Power Factor and Efficiency

1. All motors, including vertical hollowshaft motors, in the range of 1-500 horsepower, inclusive, shall be designed specifically for energy efficiency and high power factor. The motor efficiency and power factor shall meet or exceed the values listed in the table below when the motors are tested in accordance with the NEMA preferred test method IEEE 112A, Method B, Dynamometer. Each motor shall meet the minimum guaranteed efficiency value indicated in the table below. All tests shall be performed in accordance with the procedures contained in NEMA Standard MG1-12.58.

**Table 12-11
FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS
ENCLOSED MOTORS**

HP	2 POLE		4 POLE		6 POLE		8 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	75.5	72	82.5	80	80	77	74	70
1.5	82.5	80	84	81.5	85.5	82.5	77	74
2	84	81.5	84	81.5	86.5	84	82.5	80
3	85.5	82.5	87.5	85.5	87.5	85.5	84	81.5
5	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91	89.5	90.2	88.5	89.5	87.5
25	91	89.5	92.4	91	91.7	90.2	89.5	87.5
30	91	89.5	92.4	91	91.7	90.2	91	89.5
40	91.7	90.2	93	91.7	93	91.7	91	89.5
50	92.4	91	93	91.7	93	91.7	91.7	90.2
60	93	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93	91.7	94.1	93	93.6	92.4	93	91.7
100	93.6	92.4	94.5	93.6	94.1	93	93	91.7

**Table 12-11
FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS
ENCLOSED MOTORS**

HP	2 POLE		4 POLE		6 POLE		8 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
125	94.5	93.6	94.5	93.6	94.1	93	93.6	92.4
150	94.5	93.6	95	94.1	95	94.1	93.6	92.4
200	95	94.1	95	94.1	95	94.1	94.1	93
250	95.4	94.5	95	94.1	95	94.1	94.5	93.6
300	95.4	94.5	95.4	94s.5	95	94.1		
350	95.4	94.5	95.4	94.5	95	94.1		
400	95.4	94.5	95.4	94.5				
450	95.4	94.5	95.4	94.5				
500	95.4	94.5	95.8	95				

**Table 12-12
FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS
RATED 600 VOLTS OR LESS (RANDOM WOUND)
OPEN MOTORS**

HP	2 POLE		4 POLE		6 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77	74	85.5	82.5	82.5	80
1.5	84	81.5	86.5	84	86.5	81.5
2	85.5	82.5	86.5	84	87.5	81.5
3	85.5	82.5	89.5	84	88.5	86.5
5	86.5	84	89.5	84	89.5	87.5
7.5	88.5	86.5	91	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93	91.7	91.7	90.2
20	91	89.5	93	91.7	92.4	91
25	91.7	90.2	93.6	92.4	93	91.7
30	91.7	90.2	94.1	93	93.6	92.4
40	92.4	91	94.1	93	94.1	93
50	93	91.7	94.5	93.6	94.1	93
60	93.6	92.4	95	94.1	94.5	93.6
75	93.6	92.4	95	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95	94.1
125	94.1	93	95.4	94.5	95	94.1

Table 12-12
FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS
RATED 600 VOLTS OR LESS (RANDOM WOUND)
OPEN MOTORS

HP	2 POLE		4 POLE		6 POLE	
	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
150	94.1	93	95.8	95	95.4	94.5
200	95	94.1	95.8	95	95.4	94.5
250	95	94.1	95.8	95	95.4	94.5
300	95.4	94.5	95.8	95	95.4	94.5
350	95.4	94.5	95.8	95	95.4	94.5
400	95.8	95	95.8	95	95.8	95
450	95.8	95	96.2	95.4	96.2	95.4
500	95.8	95	96.2	95.4	96.2	95.4

NOTES:

(Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.

(TEFC efficiencies apply to both horizontal and vertical motors.

2. Motors rated 50 horsepower or greater shall be individually tested at the factory before shipment, with a copy of test results provided for the Engineer, to assure compliance with the efficiency and power factor specifications.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Motors shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Motors shall be properly protected from weather hazards. Motors shall not be allowed to be wrapped tightly in plastic while outdoors. Motors delivered to the site which will not be put in service for a time in excess of 30 calendar days, whether in storage or installed, shall have the shafts rotated a minimum of five (5) rotations every 30 days.
- B. Motors provided with space heaters shall have temporary power applied to the heaters no later than 30 calendar days after delivery to the site until permanent power can be applied to the heaters.

- C. Motors that, in the opinion of the Engineer, have not been properly protected shall be inspected by the manufacturer's representative. Any required electrical corrections for testing shall be made at the Contractor's expense prior to acceptance and/or use.
- D. All motors shall operate without any undue noise or vibration and shall show no signs of phase unbalance.

3.03 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 - 1. Witnessed Shop Tests
 - a. All motors shall be shop tested and inspected in accordance with the equipment manufacturer's standard procedures. Shop tests for motors 100 horsepower and larger may be witnessed by the Engineer. The manufacturer's testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days' notice shall be given the Engineer prior to tests and inspection dates.
 - b. In addition to the efficiency and power factor testing specified herein, each motor shall be tested to determine compliance with the applicable requirements of the IEEE, ANSI and NEMA. Tests shall be as follows:
 - 1) Motors less than 50 HP:
 - a) Each motor shall be subjected to a standard, short commercial test including the following:
 - i. Running current, no load
 - ii. Locked rotor current
 - iii. High potential
 - iv. Winding resistance
 - v. Bearing inspection
 - 2) Motors between 50 and 100 HP
 - a) Each motor shall be subjected to the above tests and shall be furnished with certified test results.
 - 3) Motors larger than 100 HP
 - a) Each motor shall be furnished with certified test results. Each motor shall be subjected to a complete test consisting of full load

heat run, percent slip, running load current, locked rotor current, breakdown torque (calculated), starting torque, winding resistance, high potential, secondary current and voltage at collector rings (wound rotor), efficiencies at 100, 75 and 50 percent of full load, power factors at 100, 75 and 50 percent of full load and bearing inspection. Tests will be witnessed by the Engineer where specifically indicated.

4) Test Reports

- a) All test results for motors over 100 horsepower shall be submitted to the Engineer for approval. Copies of witnessed test raw data shall be submitted to the Engineer immediately upon completion of such tests.

2. Field Tests – NOT USED

- a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 01, and Section 26 05 00 – Basic Electrical Requirements.

ALL ELECTRIC MOTORS FURNISHED FOR THIS PROJECT ONE (1) HORSEPOWER OR LARGER SHALL HAVE THE INFORMATION REQUIRED IN THE FOLLOWING TABULATION COMPLETED. SEE EXHIBIT "A" .

END OF SECTION

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SECTION 26 09 16
ELECTRIC CONTROLS AND RELAYS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.
- B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and Labeled in compliance with IEC standards is not acceptable.
- C. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 53 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

- A. Products specified herein shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)/International Society of Automation (ISA):
 - a. ANSI/ISA 12.12.01 – Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 – Enclosures for Electrical Equipment.
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 4. Underwriters Laboratories (UL):
 - a. UL 508A – Standard for Industrial Control Panels.

- b. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Spare Parts List
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. In addition to the manufacturer recommended spare parts, the following spare parts shall be provided for the local control stations:
 - 1. One (1) contact block of each type furnished on the project
 - 2. One (1) indicating light lens of each color furnished on the project
 - 3. One (1) LED lamp of each color furnished on the project

- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

PART 2 – PRODUCTS

2.01 CONTROL COMPONENTS

A. Manufacturers

- 1. Control components shall be manufactured by Eaton, The Square D Company, GE by ABB, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

B. Pilot Devices

1. General

- a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (e.g., HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc.).
- b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.
- c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.
- d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.
- e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.

2. Pushbuttons

- a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.
- b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated

for 5A at 250VAC/DC (minimum), but no less than required for the application.

- c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

3. Selector Switches

- a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.
- b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.
- c. Where indicated in the Drawings or Specifications, provide spring return positions.
- d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights

- a. Indicating lights shall be LED type, with the proper voltage rating to suit the application, and push-to-test feature.
- b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:

Color	Designation
Red	"Run", "On", "Open"
Green	"Off", "Closed"
Amber	"Alarm", "Fail"
White	"Control Power On"

5. Emergency Stop and Tagline Switches

- a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.
- b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.
- c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers

1. General

- a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.
- b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.
- c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

2. Control and Pilot Relays

- a. Relays shall have a clear or translucent housing that allows the contacts to be visually inspected without disassembly.
- b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
- c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.

3. Time Delay Relays

- a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.
 - b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.
 - c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.
 - d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.
4. Elapsed Time Meters
- a. Elapsed time meters shall be non-resettable type with no less than a four (4) digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks

1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 – #8 AWG.
2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (e.g., 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.
3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.02 LOCAL CONTROL STATIONS

- A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.
- B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.

- C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Die Cast Zinc
Indoor Dry Non-process Area	NEMA 12, Die Cast Zinc
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or Thermoplastic Polyester
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

- D. In hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

- E. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.
- F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class I, Division 1 and Class II, Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class I, Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.
- G. Provide a nameplate on each local control station in accordance with Section 26 05 53 – Identification for Electrical Systems. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words “LOCAL CONTROL STATION”.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- B. Local control stations shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the enclosure, at the equipment height where appropriate and permitted by the NEC, or as shown otherwise on the Drawings.
- C. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.
- D. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The device shall be bonded to the equipment enclosure with an insulated green bonding conductor.
- E. Local control station covers shall be bonded to the local control station enclosure with an insulated green bonding conductor.
- F. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.
- G. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation panelboards as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles, and arrangements/locations conforming to the panelboard schedules shown on the Drawings.
- B. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 53 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. National Electrical Contractors Association (NECA):
 - a. NECA 407 – Standards for Installing and Maintaining Panelboards.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. NEMA PB 1 – Panelboards.
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 4. Underwriters Laboratories (UL):
 - a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.
 - b. UL 67 – Standard for Panelboards.

- c. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
- d. UL 943 – Ground Fault Circuit Interrupters.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings.
 - 2. Spare Parts List.
 - 3. Operation and Maintenance Manuals.
 - 4. Reports of Field Tests.
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.
 - 3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.
 - 4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., LP-1, PP-2, etc.).

1.05 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01. The manuals shall include:

1. Instruction books and/or leaflets.
2. Recommended spare parts list.
3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

1.06 SPARE PARTS

- A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

- A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. It is the intent of these specifications that the panelboards be produced by a single manufacturer who shall be responsible for matching all components and providing equipment which functions together as a system.
- C. Distribution panelboards, those identified with a prefix “DP” on the Drawings, shall be the PRL4X Series by Eaton, I-Line Series by Square D, GE by ABB equivalent, or Siemens Energy and Automation, Inc. equivalent.
- D. Power panelboards, those identified with prefix “PP” on the Drawings, shall be the PRL3X Series by Eaton, NF Series by Square D, GE by ABB equivalent, or Siemens Energy and Automation, Inc. equivalent.
- E. Lighting and instrument panelboards, those identified with prefix “LP” and “IP” respectively on the Drawings, shall be the PRL1X or PRL2X Series by Eaton, NQ Series by Square D, GE by ABB equivalent, or Siemens Energy and Automation, Inc. equivalent.

- F. Combination power units shall be Mini-Power Center Series by Eaton, Mini-Power Zone Series by Square D, GE by ABB equivalent, or Siemens Energy and Automation, Inc. equivalent.

2.02 PANELBOARDS

A. General

1. Panelboards shall be dead-front type and shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards.
2. Where specified herein, indicated on the Drawings, or required, panelboards shall be rated for service entrance and bear a service entrance label.
3. Panelboards shall be equipped with a main circuit breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting as indicated on the Drawings.
4. Panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical for units rated 240VAC and below, and 42,000 amperes symmetrical for units rated above 240VAC, unless otherwise indicated on the Drawings.

B. Enclosures

1. Enclosures shall be UL 50 Listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI 49 or 61 gray. The enclosure shall have wiring gutters on the sides and shall be at least 5-3/4 inches deep. Wiring gutters shall be large enough to allow compliance with NEC minimum bending radius requirements for all cables to be terminated, including future cables sized for any spare circuit breakers that are shown on the Drawings.
2. All panelboards shall be provided with a dead front style trim. Additional trim requirements are as follows:
 - a. Distribution panelboards with enclosures that are rated other than NEMA 12 shall have hinged covers over each vertical wiring gutter to allow access to all branch mounted device terminations without removing the panel trim.
 - b. Power, lighting, and instrumentation panelboards with enclosures that are rated other than NEMA 12 shall be provided with a full height hinge where it is attached to the panelboard box. Trim shall be attached to the panelboard enclosure using concealed trim clamps. Resultant trim assembly shall allow

work inside the enclosure without the need to remove the panel trim from the enclosure.

3. Panelboard trims shall include a door over the dead front area to provide access to the circuit breakers and other devices. The access door shall be fastened to the trim with concealed hinges and be equipped with flush-type catches. Access doors exceeding 40 inches in height shall be equipped with a vertical bolt three-point locking mechanism, all other doors shall have a single-point mechanism. All locks shall be keyed alike.
4. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, number of wires, and bus ratings.

C. Bus Work

1. Where 3-wire bus is indicated on the Drawings, the panelboard shall be furnished with 3 phase busses and a ground bus. In addition, if a transformer with a grounded wye secondary is shown on the Drawings to be supplying a 3-wire panelboard, a neutral landing pad shall be furnished within the panelboard to provide a place to terminate the grounded conductor. Providing a 4-wire bus (3 phases plus neutral) for a 3-wire system is not acceptable.
2. Where a 4-wire bus is indicated on the Drawings, the panelboard shall be furnished with 3 phase busses, a neutral bus of equal ampacity to the phase bus, and a ground bus.
3. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel to provide full flexibility of circuit arrangement.
4. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.
5. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.
6. All bus shall be tin-plated copper and shall extend the entire useable length of the panelboard, including spaces.
7. Where required by the NEC, a bonding jumper, sized in accordance with the NEC, shall be installed between the panelboard ground bus and the neutral bus or neutral landing pad.

D. Circuit Breakers

1. Main and branch circuit breakers shall be bolt-on, UL 489 Listed molded-case type with trip ratings as indicated on the Drawings. Unless otherwise indicated, circuit breakers shall be manually operable, with automatic trip-free operation, and shall provide inverse-time-limit overload and instantaneous short-circuit protection. All circuit breakers shall have quick-make, quick-break, toggle mechanisms for manual as well as automatic operation.
2. Main circuit breakers shall be individually mounted. Branch-mounted main circuit breakers are not acceptable unless specifically indicated on the Drawings. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location(s).
3. Tandem or half-size circuit breakers are not acceptable.
4. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. The number of poles and trip ratings shall be as indicated on the Drawings. Where a trip rating is not indicated on the Drawings, provide a 20A circuit breaker.
5. Circuit breakers for panelboards rated 240VAC and below shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating. Circuit breakers for panelboards rated above 240VAC shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.
6. Unless indicated otherwise on the Drawings, circuit breakers with smaller than 225-ampere frames shall be the thermal-magnetic type. Thermal and magnetic trip elements may be fixed or adjustable.
7. Where indicated on the Drawings, and for circuit breakers of 225-ampere frames and larger, circuit breakers shall have interchangeable electronic trip units (ETU) and adjustable trip elements and time delays. Provide electronic trip units with the adjustable functions indicated on the Drawings (e.g., Long, Short, Instantaneous, Ground, etc.).
8. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault circuit interrupters (i.e., GFI/GFCI) complete with "TEST" push button, and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Ground fault circuit interrupter style circuit breakers shall be UL 943 Listed. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.
9. Where indicated on the Drawings, circuit breakers shall be 100% rated.

10. Where indicated on the Drawings, main circuit breakers shall be provided with a shunt trip device to trip the breaker from a remote location by means of a trip coil energized from a separate circuit. A 120 VAC shunt trip shall be capable of operating at 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.
11. Where indicated on the Drawings, or as required, circuit breakers shall be provided with a padlockable hasp or handle padlock attachment (lock-off device) for padlocking in the "OFF" position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Where indicated on the Drawings, or as required, branch circuit breakers shall be provided with a similar attachment (lock-on device) for padlocking in the "ON" position for critical circuits (e.g., fire alarm control panel circuits) which must remain energized.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard (including both new panelboards and existing panelboards modified under this project). The Contractor shall maintain in each panelboard, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.03 COMBINATION POWER UNITS

- A. Combination power units shall be installed as specified herein and indicated on the Drawings. The unit shall be a combination of a transformer and a lighting panelboard. Transformer rating, primary circuit breaker rating, secondary circuit breaker rating, and panelboard bus rating shall be as indicated on the Drawings. The transformer and panelboard shall meet the requirements for these products as specified herein and elsewhere in these Specifications.
- B. Combination power units located outdoors or in indoor wet locations shall be suitable for outdoor use and be provided in a NEMA 3R (minimum) enclosure unless otherwise indicated on the Drawings.
- C. Combination power units shall have all copper windings and terminations. The transformer shall be 115°C temperature rise and epoxy resin encapsulated.

2.04 DC POWER SYSTEM PANELBOARD

- A. The DC power system panelboard shall meet the requirements specified herein for the lighting panelboards with the following exceptions:

1. Circuit breakers shall have an interrupting rating at 250 VDC that matches the panelboard short circuit rating.

2.05 SURGE PROTECTIVE DEVICES

- A. Surge protective devices (SPD) shall be provided either integral to the panelboard or as a separate unit external to the panelboard enclosure, as indicated on the Drawings.
- B. Integral SPDs shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Panelboards and combination power units shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.
- B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.
- C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.
- D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.
- E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.
- F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.

- G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 - 1. Field Tests
 - a. Prior to termination of any conductors to the circuit breakers, all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megohmmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.
 - b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

END OF SECTION

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SECTION 26 25 13
LOW VOLTAGE BUSWAY

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory condition the low voltage busway systems, complete with all necessary fittings, supports, and accessories as specified herein and indicated on the Drawings.
- B. All equipment specified in this Section shall be furnished by the busway manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

1.02 CODES AND STANDARDS

- A. The low voltage busway systems shall be designed, manufactured, and tested in accordance with the following codes and standards:
 - 1. National Electrical Manufacturers' Association (NEMA):
 - a. BU 1 – Busways
 - 2. National Electrical Code (NEC)
 - a. Article 368 – Busways
 - 3. Underwriters Laboratories (U.L.)
 - a. ANSI/UL-857
- B. Each component of the low voltage busway system shall be UL listed and the assembly shall bear the UL label. The listing shall include mounting of the busway in any position (i.e., horizontal, vertical, etc.) without derating.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals

3. Spare Parts List
4. Reports of Certified Shop Tests

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings for each busway system shall include but not be limited to:
 1. Equipment specifications and product data sheets identifying all electrical ratings, finishes, all materials used, and methods of fabrication.
 2. Complete busway system dimensioned layout drawings, isometric drawings, installation details, and locations of supports and fittings such as firestop and weatherseals. Include details of wall and floor penetrations.
 3. Weights of all sections and fittings.
 4. Bill of material list for each busway system.
 5. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and energizing of the busway.
 6. Manufacturer's warranty statement.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATIONS AND MAINTENANCE MANUALS

- A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01. The manuals shall include:

1. Instruction books and/or leaflets.
 2. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during installation.
- B. The Contractor shall supply a copy of NEMA Bulletin BU1.1 for installation and for maintenance instructions.

1.06 SPARE PARTS

- A. The busway systems shall be furnished with all spare parts as recommended by the equipment manufacturer. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each busway system:

Number Required	Description
1 set	Joint covers

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products on site in accordance with the manufacturer's instructions and the provisions of these Contract Documents.
- B. Accept busway on site in factory containers. Inspect for damage.
- C. Protect from moisture by using appropriate coverings. Store in dry interior locations.

1.08 FIELD MEASUREMENTS

- A. The Contractor shall provide and be responsible for all field measurements and provide them to the manufacturer resulting in a complete and operable installation.

1.09 CONSTRUCTION SEQUENCING

- A. The Contractor shall reference Section 01 14 00 – Coordination with Owner’s Operation of these Specifications.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by the Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

- B. It is the intent of these specifications that all components of the busway system be provided by one manufacturer who shall have the sole responsibility of matching all components and providing equipment which functions together as a system.
- C. The low voltage busway shall be I-line as manufactured by The Square D Company, Pow-R-Way III as manufactured by Eaton Spectra Series as manufactured by General Electric, or approved equal.

2.02 FEEDER BUSWAY

A. General

1. Furnish and install complete low impedance prefabricated busway distribution systems as specified herein and shown on the Drawings.
2. The busway shall bear a UL label.
3. Busway shall be 480 volts, 3 phase, 3 or 4 wire (full neutral) as indicated on the Drawings with 50% capacity integral ground bus. The busway housing shall not serve at the ground bus.
4. The busway ampere ratings and short-circuit rating shall be as shown on the Drawings.
5. The Contractor shall be responsible for routing the busway to coordinate with the other trades. Final field measurements shall be made by the Contractor prior to the release of the busway for fabrication.
6. The busway system shall consist of standard 2'-0" through 10'-0" sections with special sections and fittings furnished to suit the application.

B. Short Circuit Rating and Tests

1. The short-circuit rating of the busway shall be determined according to UL Standard No. 857. This rating shall be based upon actual tests at the rated short-circuit current.

2.03 BASIC CONSTRUCTION

A. Housing

1. The busway shall be furnished in an [indoor NEMA 1] [outdoor NEMA 3R] enclosure.
2. The totally enclosed housing shall be manufactured by the busway manufacturer. Modifications of busway to make it totally enclosed by other than the busway manufacturer is not acceptable.

3. The indoor busway housing shall be constructed of aluminum and shall be provided with a suitable protective finish of ANSI 61 gray epoxy paint electrostatically applied. The housing shall receive an iron phosphate pretreatment inside and out prior to finish coating.
4. The indoor busway housing shall be totally enclosed, non-ventilated for protection against mechanical damage and dust accumulation.
5. Outdoor busway housings shall be galvanized steel and have drain holes. All seams shall be sealed. Splice plates and joint covers shall have neoprene gaskets and removable rubber drain plugs. Drain plugs located on the underside of the duct shall be removed by the Contractor to allow for drainage.

B. Joints

1. The busway joints shall be of the one-bolt type which utilizes a high strength steel bolt(s) and Belleville washer to maintain proper pressure over a large contact surface area.
2. The bolt(s) shall be torque indicating, fully insulated, and at ground potential.
3. The bolt shall be two-headed design to indicate when proper torque has been applied and shall require only a standard long handle wrench to be properly activated.
4. Access shall be required to only one side of the busway for tightening joint bolts.
5. Joint covers shall be furnished and installed with captive hardware.
6. Busway rated 800A and above shall be suitable for removing any joint connection assembly to allow electrical isolation or physical removal of a busway length without disturbing adjacent busway lengths.

C. Bus Bars

1. The bus bars, including ground bus, shall be fabricated from high strength, 98% conductivity tin-plated copper.
2. Each bus bar shall be insulated over its entire length, except at joints and contact surfaces, with a UL listed Class B (130 degrees C) rated insulating material. Tape or heat-shrink sleeve insulation, or any other method of insulation which can allow air gaps or insulation breakdown, is not acceptable.
3. The temperature rise at any point in the busway system shall not exceed 55 degrees C rise above a 40 degrees C ambient temperature when operating continuously at rated load current.

4. Sheets of polyester (mylar) film shall be placed between bus bars and between bus bars and the housing.

D. Support of Busway

1. Hanger spacing shall not exceed manufacturer's recommendations.
 - a. Indoor busway shall be approved for hanger spacing of up to 10'-0" on horizontal runs and 16'-0" when vertically mounted.
 - b. Outdoor busway shall be suitable for hanger spacing of up to five feet (5'-0") on horizontal and vertical runs.

E. Cable Tap Boxes

1. Cable tap boxes shall be furnished and installed to transition from busway to cable as specified herein and indicated on the Drawings.
2. Cable tap boxes shall be the [end] [center] [plug-in] type.
3. Cable tap boxes shall be furnished with lugs of the proper size and quantity commensurate with the cable(s) to be terminated in the box.

2.04 VOLTAGE DROP

- A. The voltage drop (input voltage minus output voltage) specified shall be based on the busway operating at full rated current and at stabilized operating temperature in 30 degrees C ambient temperature.
- B. The three-phase, line-to-line voltage drop shall not exceed 2.4 volts per hundred feet at 40% power factor concentrated load.
- C. The line-to-line voltage drop shall not exceed 3.3 volts per hundred feet at the load power factor which produces maximum voltage drop in the busway.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The busway systems shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions and additional instructions detailed in NEMA publication BU1.1 shall be included with the equipment at time of shipment. The equipment shall be suitably protected until accepted by the Owner.

- B. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include, but not be limited to, the following:
 - 1. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.
 - 2. Assemble all sections, remove all shipping braces, and connect all shipping split mechanical and electrical connections.
- C. Install busway length with expansion fitting at each location where busway run crosses building expansion joint.
- D. Contractor shall not install busway when installation location is not protected from moisture.
- E. Install busway with integral fire stops located where busway penetrates fire-rated walls and floors. Seal around opening to maintain fire-rating of wall or floor.
- F. Install busway with integral weather seal located where busway penetrates [an exterior wall] [the roof]. Provide [wall] [roof] flange and seal around opening to maintain weather-tight installation.
- G. Provide concrete curb around interior floor penetrations.

3.02 PAINTING

- A. Prior to final completion of the work, all metal surfaces of the busway systems shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.03 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 - 1. Certified Shop Tests and Reports
 - a. Submit notarized and certified copies of all test reports.
 - b. As a minimum, the entire busway system shall go through a quality inspection before shipment. This inspection shall include, but is not limited to, the following:
 - 1) Physical inspection of the structure, supports and the electrical conductors.
 - 2) General electrical tests

- 3) AC dielectric tests of the busway system
 - 4) Markings/labels, including instructional type, Underwriters Laboratory (U.L.), and inspector's stamps.
- c. The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the busway system.
 - d. The busway shall be given routine factory tests in accordance with the requirement of the ANSI and NEMA standards. Temperature rises may be certified from basic design.
2. Field Tests
- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.
 - b. After installation, busway shall be tested for insulation levels. Insulation resistance between bus bars and between bus bars conductor and ground shall be tested. Testing for insulation levels shall be as follows:
 - 1) Apply 1,000 VDC from a Megaohmmeter for one (1) minute. Resistance shall be no less than 100 Megaohms.
- B. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all switches, and receptacles as shown on the Drawings.
- B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 26 05 33.16 – Boxes for Electrical Systems for outlet box requirements.
- C. Reference Section 26 05 00 – Basic Electrical Requirements and Section 26 05 19 – Low-Voltage Conductors and Cables.

1.02 CODES AND STANDARDS

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Wiring devices shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 2. Underwriters Laboratories (UL):
 - a. UL 20 – General Use Snap Switches.
 - b. UL 498 – Standard for Attachment Plugs and Receptacles.
 - c. UL 943 – Ground Fault Circuit Interrupters.
 - d. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include, but not be limited to:
 - 1. Product data sheets.

1.05 SPARE PARTS

- A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.06 IDENTIFICATION

- A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. The Contractor shall use the products of a single manufacturer for each type of wiring device.
- C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:
 - 1. Where the selected plate manufacturer does not manufacture a suitable finish plate.
 - 2. For heavy-duty receptacles rated at more than 30A.

3. Where non-standard plates are required, specified, or shown.
- D. The Contractor shall furnish and install all wiring devices and device plates.
- E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, or Engineer approved equal.
- F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

2.02 WIRING DEVICES

- A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double -pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120-277VAC and shall be UL 20 Listed.
- B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VAC and shall be UL 498 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.
- C. Special purpose receptacles (e.g., welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.
- D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VAC and shall be UL 943 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.
- E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A.
- F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.
- G. Wiring devices shall be approved for use with stranded conductors if stranded conductors are to be used with the device. Reference Section 26 05 19 – Low-Voltage Conductors and Cable for conductor requirements

2.03 DEVICE PLATES

- A. Device plates for indoor flush-mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled

on the rear so as to lie flat against the wall. Device plates shall be provided with a gasket.

- B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK-1VS-A, Crouse-Hinds #DS185, or Engineer approved equal for wall switches. Device plates for receptacles shall be "in-use" style, and shall be fully closable when a plug/cord is inserted. "In-use" weatherproof covers shall be rugged, minimum 3 ¼" depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or Engineer approved equal.
- C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32 or Engineer approved equal for switches, and Crouse-Hinds DS23 or Engineer approved equal for receptacles.

2.04 PLUGS

- A. The Contractor shall furnish suitable plugs with equipment furnished under the respective Specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

2.05 PROCESS INSTRUMENTS

- A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument, etc.) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or Engineer approved equal. For hazardous locations, the device shall be UL 1203 Listed.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.
- B. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and outlet boxes.
- C. Wiring device box (outlet box) mounting heights shall be as specified in Section 26 05 33.16 – Boxes for Electrical Systems.

- D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.
- E. Receptacles installed in toilet, locker, and bathrooms, and within 6 feet of a sink, shall be of ground fault circuit interrupter (GFCI) type. GFCI receptacles shall also be furnished and installed in additional locations where indicated on the Drawings, and as required by the NEC.
- F. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14-point font.

3.02 CIRCUITING

- A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

END OF SECTION

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SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.
- B. Disconnect switches for process instruments are not included in the scope of this Section and shall be as specified in Section 26 27 26 – Wiring Devices.
- C. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 53 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. Disconnect switches shall be designed, manufactured, and/or Listed to the following standards as applicable:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 – Enclosures for Electrical Equipment.
 - b. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 70 – National Electrical Code (NEC).
 - 3. Underwriters Laboratories (UL):
 - a. UL 98 – Enclosed and Dead-Front Switches.
 - b. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Spare Parts List
 - 3. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.
 - 3. Assembled weight of each unit.
- D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

- A. The equipment shall be furnished with all spare parts as recommended by the equipment manufacturer.
- B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.
- C. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.06 IDENTIFICATION

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the equipment name with which it is associated (e.g., Pump No.1 DSW). Equipment identification shall be in accordance with Section 26 05 53 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.
- B. Switches shall be manufactured by the Square D Company, Eaton, the GE by ABB, Rockwell Automation (Allen-Bradley), or Siemens Energy and Automation, Inc.

2.02 DISCONNECT SWITCHES

- A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.
- B. Disconnect switches for non-hazardous areas shall be UL 98 Listed. Disconnect switches for hazardous areas shall be UL 1203 Listed.
- C. Switches shall meet NEMA Standard KS 1 type HD requirements, be, single-throw, be externally operated, and be fused or non-fused as indicated on the Drawings. Switches shall have the number of the poles, voltage, and ampere ratings as shown on the Drawings.
- D. Enclosure Types and Materials
 - 1. In non-hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel

Area Designation	Enclosure Type and Material
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. In hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.
4. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.
- E. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.
- F. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.
- G. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides "finger-safe" protection when the door of the enclosed switch is open.
- H. Disconnect switches shall be furnished with a manufacturer-supplied ground lug kit for termination of equipment grounding conductors. Where a grounded (neutral) conductor is shown on the Drawings in the conduits connected to the disconnect switch, a manufacturer-supplied neutral bar shall be furnished for termination of the grounded conductors. Third party ground lug and neutral lug kits not supplied by the disconnect switch manufacturer are not acceptable.

- I. Fused disconnect switches shall be furnished for motor operated valve and gate actuators where shown on the Drawings. The Contractor shall coordinate the supply of these fused switches with the specific requirements of the actuator. Fuses with fast fault clearing times may be required for modulating valve actuators.
- J. Disconnect switches for all motors connected to variable frequency drives (VFDs) shall be furnished with a factory installed electrical interlock kit that includes one (1) early-break auxiliary contact rated for 5A (minimum) at 120 VAC to be used to open the control circuit before the main switch blades break.
- K. Disconnect switches for use on circuits utilizing shielded VFD cable(s), shielded submersible pump cable(s), or similar special cable constructions, shall be furnished with the configuration, accessories, and/or appurtenances necessary for use with such cables as described in Part 3 herein.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Disconnect switches shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the operating handle mechanism (and not to exceed 6ft 7in to the center of the operating handle grip when in its highest position), at the equipment height where appropriate and permitted by the NEC, or where shown otherwise.
- B. Disconnect switches shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- C. Where disconnect switches are shown on the Drawings to be installed on circuits utilizing shielded VFD cable(s), shielded submersible pump cable(s), or similar special cable constructions, the Contractor shall coordinate the configuration and installation of the disconnect switches with the switch manufacturer and respective cable and/or pump/equipment manufacturer(s). These types of cables require special methods to be utilized for termination, grounding, etc., and may also require the addition of isolated (from other ground conductors, enclosure/raceway grounding, etc.) ground/shield termination provisions in the disconnect switch for pass-through of the cable internal shield/ground conductor(s). Properly coordinating and executing the configuration and installation of disconnect switches with these cable types shall be the sole responsibility of the Contractor.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:

1. Field Tests

- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.
- B. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.02 CODES AND STANDARDS

- A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).
- B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable.
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE C62.41.3 – Guide for Surge Voltages in Low-Voltage AC Power Circuits
 - 2. Illuminating Engineering Society (IES)
 - 3. National Fire Protection Association (NFPA)
 - a. NFPA 70 – National Electric Code (NEC).
 - 4. Underwriters Laboratories (UL)
 - a. UL 924 – Emergency Lighting and Power Equipment
 - b. UL 844 – Luminaires for Use in Hazardous (Classified) Locations
 - c. UL 916 – Standard for Energy Management Equipment
 - d. UL 1012 – Standard for Safety Power Units Other Than Class 2
 - e. UL 1598 – Luminaires

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Operation and Maintenance Manuals
 - 3. Spare Parts Lists
- B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor for resubmittal without review.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.
 - 3. Photometric curves.
 - 4. LED data including efficiency (Efficacy lumens/watt) information.
 - 5. LED Driver information
 - 6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.
 - 7. Manufacturer's warranty information.
 - 8. Manufacturer's connection/wiring diagram for each astronomical time switch system used on the project.
 - 9. System (entire fixture assembly) efficiency data.
 - 10. Pole and foundation calculations.

- D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.
- E. Manufacturer's model/series and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a model/series describing the various types of fixtures shall be used as a guide only and does not exclude all the required accessories or hardware that may be required for a complete installation.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 01.

1.06 SPARE PARTS

- A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following additional spare parts shall be furnished:
 - 1. A minimum of one (1) LED driver for every ten (10) drivers (of the same type) installed.
- B. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 LIGHTING CONTROLS

- A. The lighting systems shall be controlled as specified herein and indicated on the Drawings.

1.08 WARRANTY

- A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.
- B. Warranty shall be provided for the entire fixture and shall include all parts and accessories.. Submittals received without written warranties as specified shall be rejected in their entirety.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be

designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

- B. The fixture schedule indicates the basis-of-design manufacturer(s) for each fixture type. The Contractor shall submit photometric calculations for each space and/or area where the Contractor wishes to use an equivalent fixture in accordance with Section 26 05 00 – Basic Electrical Requirements. Fixtures will be approved or denied as equivalent on a per-fixture and/or per-space/area basis.

2.02 FIXTURES

- A. All lighting fixtures shall be furnished complete with all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all accessories, characteristics, and functionality as specified.
- B. Fixture leads shall be as required by NEC. Fixtures shall be grounded by the equipment grounding conductor in the conduit.
- C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.
- D. Emergency and exit fixtures shall be UL 924 Listed and have a minimum 90 minutes battery back-up.
- E. Fixtures for use in hazardous locations shall be UL 844 Listed.
- F. Fixtures specified to be damp or wet locations rated shall be UL 1598 Listed.
- G. Fixtures shall be as specified in the [Choose an item](#)

Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
LC1 LPx LWx	[XXX]W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, 90 CRI, lineal ribbed frosted acrylic lens, medium distribution, gasketed fiberglass housing, stainless steel latches, 4ft, XXXX lumen minimum, and wet location Listed.	Holophane EMS LED Series, or Engineer approved equal.
LC1 LPx LWx	[XXX]W (max)	Ceiling-mounted, 120VAC, LED striplight fixture with plug-in wiring, color temperature of 3000K, 90 CRI, frosted acrylic lens, white steel housing, 4ft, XXXX lumen minimum.	Holophane HZL1D Series or Engineer approved equal.
LC2 LPx LWx	[XXX]W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, 90 CRI, clear acrylic lens, medium distribution, gasketed fiberglass housing, 4ft, XXXX lumen minimum, and wet location Listed.	Holophane EMW LED Series, or Engineer approved equal.

Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
LC3 LPx LWx LLx	[XXX]W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, 90 CRI, prismatic borosilicate glass lens, medium distribution with uplight, corrosion-resistant white cast aluminum housing, XXXX lumen minimum, integral photocell, and wet location Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	Holophane Petrolux PXLW/PXHW Series, or Engineer approved equal.
LC4 LPx LWx LLx	[XXX]W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, 90 CRI, prismatic borosilicate glass lens, medium distribution with uplight, corrosion-resistant white cast aluminum housing, XXXX lumen minimum, integral photocell, and Class 1, Division 2, Group D Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	Holophane Petrolux PXLH/PXHH Series, or Engineer approved equal.
LC5 LPx LWx LLx	94W (max)	Ceiling-mounted, 120-277VAC, LED light fixture, color temperature of 5000K, heat-resistant prismatic glass globe with stainless steel wire guard, dome reflector, gray die-cast aluminum housing, 8000 lumen minimum. Class I, Division 1, Group D Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	Holophane HRLL Series, or Engineer approved equal.
LC6	[XX]W (max)	Ceiling (junction box) mounted LED light fixture, 120-277VAC with 0-10V dimming, color temperature of 3000K, 90 CRI, diffuse lens, aluminum frame with white finish, XXXX lumen minimum.	Juno Slimform LED JSF Series or Engineer approved equal.
LP1	[XXX]W (max)	Pendant-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, prismatic borosilicate glass lens, medium distribution, white cast aluminum housing, XXXX lumen minimum, and damp location Listed.	Holophane Phuzion PHZ Series, or Engineer approved equal.
LP2	[XXX]W (max)	Pendant-mounted, 120-277VAC, LED light fixture, color temperature of 5000K, clear glass lens, wide distribution, anodized aluminum housing and heat sinks, XXXX lumen minimum. Damp location Listed.	Crouse-Hinds IHB LED Series, or Engineer approved equal.
LR1	[XXX]W (max)	Recessed troffer 120-277VAC, 2ft x 4ft LED light fixture, 3000K color temperature, XXXX lumen minimum, cold rolled steel, pre-painted housing, acrylic linear prismatic diffuser, and integral battery backup with 90 minutes illumination time.	Lithonia VTL Series, or Engineer approved equal.
LW1	95W (max)	Wall-mounted, 120-277VAC, full-cutoff LED light fixture, color temperature of 5000K, IESNA Type 2 Medium distribution, black A360-cast aluminum housing, 9900 lumen minimum, integral photocell, integral battery backup with 90 minutes illumination time, and wet location Listed.	Holophane HLWPC2 Series, or Engineer approved equal.

Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
LW2	83W (max)	Wall-mounted, at 90 degrees on wall, 120-277VAC, LED light fixture, color temperature of 5000K, 90CRI, prismatic borosilicate glass lens, IESNA Type III Medium distribution, white die-cast aluminum housing, 12000 lumen minimum, and wet location Listed.	Holophane PXHW SERIES, or Engineer approved equal.
LW3 LLx	[XXX]W (max)	Wall (yoke) mounted, 120-277VAC, LED light fixture, color temperature of 3000K, prismatic borosilicate glass lens, 3x3 distribution, XXXX lumen minimum, black die cast aluminum housing, integral photocell receptacle, wet location Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	Holophane Predator PSLED Series, or Engineer approved equal.
LW4	70W (max)	Wall lantern, 120VAC with standard E26 light bulb socket, cast aluminum frame with black powdercoat finish, frosted glass panes. Furnish with LED lamp (10W, 2700K).	Wynfield Outdoor Wall Lantern by Sea Gull Lighting, or Engineer approved equal.
LL1	[XXX]W (max)	Pole-mounted, 120-277VAC, full-cutoff LED light fixture, color temperature of 3000K, IESNA roadway Type 2 distribution, black die cast aluminum housing, XXXXX lumen minimum, house-side shield, integral photocell, wet location Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	AEL Autobahn ATB0 Series, or Engineer approved equal.
LL2	[XXX]W (max)	Pole-mounted, 120-277VAC, LED light fixture, color temperature of 3000K, prismatic borosilicate glass refractor lens, narrow roadway distribution, XXXXX lumen minimum, black die cast aluminum housing, uplight skirt, house-side shield, integral photocell, wet location Listed. Furnish and install fixture on Pole Type X, reference Pole Schedule.	Holophane Mongoose Medium LED Series, or Engineer approved equal.
EW1	2-[XX]W (heads) [XX]W (battery)	Wall-mounted emergency fixture, LED heads, 120-277 VAC with 12 VDC lithium iron phosphate or nickel cadmium battery, gray corrosion and impact resistant polycarbonate housing surge and brown-out protection, and low voltage battery cut-off. NEMA 4X wet location Listed. Battery shall be sized to support the fixture and all remote heads as shown on Drawings.	Holophane Desoto DSL46, Lithonia EXTL Series, or Signify Chloride Rhino Series.
EW1a	2-[XX]W	Wall-mounted, LED two-lamp remote head fixture for Type EW1 fixture, no battery required. NEMA 4X wet location Listed.	Compatible with Type EW1
EW2	12W	Wall-mounted LED emergency fixture, 120-277 VAC with sealed nickel cadmium battery, field configurable optics, black die-cast aluminum housing, time delay shutoff, surge and brown-out protection, low voltage battery cut-off, and wet location Listed.	Lithonia AFF Series, or Engineer approved equal.

Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
EW3 ECx EPx	2-[XX]W (heads) [XX]W (battery)	Wall-mounted LED emergency fixture, LED heads, 120-277 VAC, with sealed lithium iron phosphate battery. Impact resistant, white molded polycarbonate housing. Surge and brown-out protection, low voltage battery cutoff, and self-diagnostics. Battery shall be sized to support the fixture and all remote heads as shown on Drawings.	Holophane Cortez CZQ Series, Lithonia ELM Series, or Engineer approved equal.
EW3a ECxa EPxa	2-5.3W	Wall-mounted LED two-head remote fixture for Type EW4 fixture, no battery required.	Compatible with Type EW4.
XW1 XCx	1.5W	Wall-mounted, red LED exit sign, 120-277VAC, brushed aluminum faceplate, die cast aluminum housing, single/double face as indicated on the drawings, nickel cadmium battery with self-diagnostics, brownout and surge protected, damp location Listed.	Holophane Magellan MEX Series, Lithonia LE Series, or Current Dual-lite SE Series.
XW2 XCx	1.5W (sign) 2-1.5W (heads)	Wall-mounted, combination red LED exit sign and two-lamp LED emergency fixture, 120-277VAC, white polycarbonate housing, single/double face as indicated on the drawings, brownout and surge protected, nickel cadmium battery with self-diagnostics. Damp location Listed. Battery shall be sized to support the fixture and all remote heads as shown on Drawings.	Holophane Magellan QM LED Series, Lithonia LHQM Series, or Engineer approved equal.
XW2a	2-1.5W (heads)	Wall-mounted LED two-head remote fixture for Type XW1 fixture, no battery required.	Compatible with Type XW1
XW3 XCx	5W	Wall-mounted, red LED exit sign, 120/277VAC, white die cast aluminum housing, gasketed impact resistant polycarbonate cover, brushed aluminum stencil with field-selectable chevrons, single/double face as indicated on the drawings, nickel cadmium battery with self-diagnostics, low voltage battery disconnect, brownout and surge protected. NEMA 4X wet location Listed.	Holophane DeLeon DLT LX Series, Lithonia LV Series, or ABB Emergilite Survive-All SVX Series.
XW4 XCx	7W	Wall-mounted, combination red LED exit sign and two-head LED emergency fixture, 120/277VAC, white thermoplastic housing, gasketed impact resistant polycarbonate cover, field-selectable chevrons, single/double face as indicated on the drawings, nickel cadmium battery with self-diagnostics, low voltage battery disconnect, brownout and surge protected. NEMA 4X wet location Listed.	Holophane DeLeon DLT LC Series, Lithonia WTLC Series, or ABB Emergilite Survive-All SVX Combination Series.
XW5 XCx	3W	Wall-mounted, LED exit sign, 120/277VAC, gray powder coated aluminum housing, acrylic edge-lit panel with red lettering, single/double face as indicated on the drawings, nickel cadmium battery, Class I, Division 1, Group D Listed.	Holophane HDXE Series, Signify Chloride CEX Series, or Dialight CXC Series.

Fixture Type	Fixture Wattage	Description	Basis of Design Mfr. and Model
XW6	-	Wall-mounted, self-luminous exit sign, sealed phosphor coated tubes containing tritium gas, uncolored anodized aluminum frame and housing, red faceplate, single face, tamper-proof hardware, vandal shield. Suitable for wet, harsh, corrosive, humid or explosive environments.	Lithonia D Series, Signify Chloride SL Series, or Astralite SL Series.

2.03 LED DRIVERS

- A. Drivers shall have a voltage range of 347-480V or 120-277 (as required) +/- 10% at a frequency 60Hz.
- B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.
- C. Case temperature shall be rated for -40°C through +80°C.
- D. Drivers shall have overheat protection, self-limited short circuit protection and overload protected.
- E. Drivers shall be furnished with a fused primary.
- F. Drivers shall have an output current ripple <30%
- G. Drivers shall be manufactured by Philips, Advance, Universal or equal.
- H. Drivers shall be UL Listed for damp location, UL1012, ROHS.
- I. Drivers shall meet FCC 47 Sub Part 15.
- J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.04 LEDS

- A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.
- B. Color Temperature: as specified in fixture schedule.
- C. Junction point shall be designed and manufactured to allow adequate heat dissipation.
- D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

2.05 POLES AND FOUNDATIONS

- A. Poles shall be designed to withstand calculated wind force based on wind velocity in accordance with the provisions of the Building Code for the State or Commonwealth in which the project is located.
- B. Pole mounted fixtures shall be mounted on poles as designated in the fixture schedule or as indicated on the Drawings. Poles shall have adequate handholes. Furnish and install weatherproof receptacles where indicated. All anchor bolts and nuts shall be hot-dipped galvanized steel.
- C. The Contractor shall furnish and install a concrete foundation for freestanding pole mounted fixtures as indicated on the Drawings and as required (e.g., site/roadway lighting). The Contractor shall furnish and install structural anchorage/attachment, including mounting brackets where applicable, for pole mounted fixtures that are attached to a structure (e.g., clarifiers, aeration basins, etc.).
- D. Foundation shall be designed and approved by a Professional Structural Engineer (PE) currently licensed in the State or Commonwealth in which the project is located. The wind design shall be in accordance with ASCE 7 and the Building Code for the State or Commonwealth in which the project is located. Submit signed and sealed calculations for review. Poles shall be as specified in the pole schedule below and shall be furnished with fixture types where specified in the fixture schedule:

Pole Type	Description	Mfr. and Model
A	Round, [paint color], base-mounted, tapered, XX ft, painted aluminum pole. Pole foundation shall project 24 inches above finished grade.	As selected by fixture manufacturer
B	Square, [paint color], base-mounted, straight, XX ft, painted galvanized steel pole. Pole foundation shall project 24 inches above finished grade.	As selected by fixture manufacturer
C	Round, base-mounted, straight, XX ft, black anodized aluminum pole. Pole foundation shall project 24 inches above finished grade.	As selected by fixture manufacturer
D	Round, , 8ft total height hot-dip galvanized steel pole with bolted base plate for horizontal bolted attachment to structure, platform, or walkway. Pole shall be structure mounted and shall be completely independent of (with no attachment to) guardrails/handrails. Pole base section shall include two (2) integral trade size 1-inch NTP threaded conduit fittings and a supplementary grounding electrode conductor landing pad. Pole shall include a locking swivel joint or telescoping action that allows the pole and fixture to be lowered to an accessible height for ladder-free maintenance. Reference Standard Details for additional information. <u>Coordinate all structural pole attachments with the Structural Engineer.</u>	Swivelpole ST Series or Engineer approved equal.

Pole Type	Description	Mfr. and Model
E	<p>Round, freestanding or structure-mounted (via a bolted base plate for attachment to concrete), 10ft hot-dip galvanized steel pole. Pole shall include a locking swivel joint or telescoping action that allows the pole and fixture to be lowered to an accessible height for ladder-free maintenance.</p> <p>Provide concrete pole foundation. Pole foundation shall project six (6) inches above finished grade. Reference the Standard Details on the Drawings.</p> <p>Where shown on the Drawings to be located on a concrete slab/structure, foundation shall be omitted and pole shall be bolted to the slab/structure. <u>Coordinate all structural pole attachments with the Structural Engineer.</u></p>	Swivelpole ST or F Series or Engineer approved equal

2.06 LIGHTING CONTROLS

A. Lighting Contactor and Photocell

1. Furnish and install a lighting contactor and photocell combination to control lighting as indicated on the Drawings.
2. Lighting contactors shall be as manufactured by Eaton, the Square D Company, General Electric Company, or Siemens Energy and Automation, Inc. Lighting contactors shall be heavy duty industrial type with 30A minimum rating and shall have the number of contacts required. Contactor ampere rating shall be increased as required to suit the application. Contactor coil voltage shall be as indicated on the Drawings. Contactors shall be the electrically or mechanically held type as indicated on the Drawings. Contactors shall include fused integral control power transformers. Any auxiliary relays, or other devices required for proper operation shall be included.
3. Photocells shown on the Drawings that are not integral to a fixture shall be provided by the Contractor. Photocells shall be rated for 120 VAC, 1800W, and be provided with 1/2" or 3/4" threads for box mounting.
4. In non-hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

5. Lighting contactors shall not be installed in hazardous locations.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.
- B. The Contractor shall provide and install all inserts, conduit, structural supports as required, mounting, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit connected to an outlet box where necessary or required resulting in a neat and complete installation.
- C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, etc.
- D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self-alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one-piece, with matching canopies and fittings.

- E. All wiring/cables associated with lighting equipment shall be installed in conduits or other raceways as specified. Installing wiring/cables exposed is not acceptable, unless specifically shown otherwise on the Drawings.
- F. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.
- G. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.
- H. All lighting fixtures, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.
- I. The Contractor shall support each fixture securely. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all members and supports as required to fasten and suspend fixtures from the structure.
- J. In all mechanical equipment areas, the Contractor shall install lighting fixtures after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.
- K. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures as directed.
- L. . All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools.
- M. Lighting contactors shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.
- N. The Contractor shall commission astronomical time switch systems with input from the Engineer and Owner about on/off scheduling. The commissioning shall also include setup of the device's geographic location and daylight savings time features.

3.02 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 - 1. Certified Shop Tests

- a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.
2. Field Tests
- a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

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SECTION 31 00 01
EARTHWORK

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment, and materials required to complete all work associated with excavation (including off-site borrow excavation), fill and backfill placement and compaction, coordination and payment for testing of soil materials and compaction by an independent Materials Testing Consultant as specified in Specification Section 01 45 23 – Testing Services Furnished by Contractor, constructing embankments, dewatering, construction of drainage layers, installing foundation and backfill aggregate, placing filter and separation fabrics, stockpiling topsoil and any excess suitable material, designing, installing, maintaining and removing excavation support systems, disposing of all excess and unsuitable materials, providing erosion and sedimentation control, encasing utility conduits, site grading, preparation of pavement and structure subgrades, and other related and incidental work as required to complete the work shown on the Drawings and as specified herein.
- B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.
- C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.
- D. Earthwork performed under this Contract shall be done in conformance with these specifications. Items and activities not addressed herein shall be subject to the limitations of the latest editions of the Utah Department of Transportation Standard Specifications and Standard Drawings. If there is a conflict between this specification and the Standard Specifications and Standard Drawings, the more conservative of the two shall take precedent.
- E. Erosion and Sediment Control shall be performed in accordance with Section 31 25 00 Erosion and Sedimentation Control of these specifications. If there is a conflict between this specification and the ESCPDM, the more conservative of the two shall take precedent.
- F. All fill materials (soil, aggregate, topsoil, etc.) imported to the site and onsite materials to be reused as fill, backfill, or embankment shall be subjected to the testing requirements contained in Part 3.0 of this Section. The Contractor shall retain a Materials Testing Consultant who shall perform all testing. The test results shall be used to determine if a material meets the requirements included herein. The Contractor shall furnish all necessary samples for laboratory testing and shall provide assistance and cooperation

during field tests. The Contractor shall plan their operations to allow adequate time for laboratory tests and to permit taking of field density tests during compaction.

- G. Any costs for re-testing required as a result of failure to meet compaction requirements shall be borne solely by the Contractor.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Divisions 01, 31, and 32 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Occupational Safety and Health Administration (OSHA) 29 CFR 1926 Subpart P
2. American Society for Testing and Materials (ASTM):
 - a. ASTM C127 – Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
 - b. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³))
 - d. ASTM D1140 – Standard Test Method for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
 - e. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method.
 - f. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/lb³ (2,700 kN-m/m³)).
 - g. ASTM D1883 – Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.
 - h. ASTM D2216 – Test for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
 - i. ASTM D2487 – Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

- j. ASTM D4253 – Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- k. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- l. ASTM D5268-22 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes
- m. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- n. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).

1.04 SUBSURFACE CONDITIONS

- A. Information on subsurface conditions is referenced under Division 01, General Requirements.
- B. Attention is directed to the possible location of water pipes, sanitary pipes, storm drains, and other utilities located in the area of proposed excavation. In the event excavation activities disrupt service, the Contractor shall perform all repairs at no additional cost to the Owner. The Contractor shall contact <https://www.bluestakes.org/> or 1-800-662-4111 to request underground utility location mark-out at least three (3) working days, not including the day the request is called in, but no more than ten (10) working days prior to the beginning of excavation. The Contractor shall also contact and request utility location mark-out from buried utility owners with utilities on the project site that are not participants of <https://www.bluestakes.org/>.

1.05 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, the Contractor shall submit the following:
 - 1. Evidence the Contractor has a minimum of five (5) years of experience performing excavation and backfill in flood embankments similar in size to the work for this project.
 - 2. Name and location of all material suppliers.
 - 3. Certificate of compliance with the standards specified herein for each source of each material.
 - 4. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

5. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.
6. Procedures for dewatering proposed by the Contractor shall be submitted to the Engineer for review and approval prior to any earthwork operations.
7. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.
8. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer in the State or Commonwealth in which the project is located.
9. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems and near areas where dewatering is required to facilitate construction.
10. A representative sample of the on-site or off-site source of each class of fill material weighing approximately 50 lbs. The sample shall be delivered to a location designated by the Engineer.
11. The Contractor shall be required to submit plans of open cut excavation for review by the Engineer before approval is given to proceed.
12. Submit excavation support installer qualifications with installation history.
13. Drawings and calculations on proposed excavation support systems sealed by a Professional Engineer currently registered in the in the State or Commonwealth in which the project is located.
14. Contractor shall also submit a monitoring plan developed by the excavation support design engineer.
15. Earthwork contractor qualifications.
16. All required permits and a list of disposal sites for unsuitable materials within thirty (30) consecutive days after Notice to Proceed. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.
17. Except where borrow is to be obtained from a commercial source, a borrow source development, use, and reclamation plan jointly developed by the Contractor and the property owner prior to engaging in any land disturbing activity on the

proposed source (other than material sampling that may be necessary). The Contractor's plan shall address the following

- a. Drainage: The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate, or as agreed to with the property owner
- b. Slopes: The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.
- c. Erosion Control: Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a Borrow Source Development, Use, and Erosion Control Plan to the appropriate State or Local permitting authority for approval and provide evidence of such to the Engineer for their approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary.

1.06 PRODUCT HANDLING

- A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

1.07 USE OF EXPLOSIVES

- A. The use of explosives will not be allowed for the prosecution of this work.

PART 2 – PRODUCTS

2.01 FILL MATERIALS

- A. The contractor shall be responsible for providing fill materials meeting the gradation requirements included herein.
- B. All fill materials shall be free of organic material, environmental contaminants, snow, ice, frozen soil, or other unsuitable material.
- C. Bedding material installed above and below the water table shall meet the requirements of the Utah Department of Transportation Standard Specifications and Standard Drawings.
- D. Below-grade walls shall be backfilled with Select Fill.

- E. When the excavated material from required excavations meets the requirements of Select Fill or Common Fill but is replaced with off-site borrow material for the Contractor's convenience, the costs associated with such work and material shall be borne by the Contractor.
- F. Where excavated material does not meet requirements for Select Fill or Common Fill, the Contractor shall furnish off-site borrow material meeting the specified requirements herein. Determination of whether the borrow material will be paid for as an extra cost will be made based on the contract documents.
- G. Contractor may stockpile excavated material to be used as Select Fill, Common Fill, Drainage Fill or Topsoil on site in areas designated in the Contract Documents. Soil materials may be stockpiled as necessary to sort, segregate, test, and transfer the materials. Excess material and materials considered unsuitable for reuse by the Engineer shall be removed from the site for off-site disposal. No stockpiling of excavated material is allowed in a manner or location that would permit erosion and its subsequent sedimentation in wetlands or other natural areas.

2.02 SELECT FILL

- A. Select fill shall be used where shown on the Contract Drawings.
- B. Select fill shall not include particles or lumps larger than 3 inches.
- C. Select fill used as backfill against walls shall not contain any rock larger than 1½ -inches.
- D. Select fill shall consist of non-plastic materials classifying as GW, GW-GM, GP, SW, SW-SM, SP-SM, or SP per ASTM D-2487. Select fill shall be free of organic material, environmental contaminants, snow, ice, frozen soil, or other unsuitable material.
- E. Open-graded and dense-graded UDOT aggregates meeting the gradation requirements above may be used as Select Fill.
- F. Select Fill to be used as pavement subbase material shall be UDOT Aggregate Base Course.
- G. Select Fill shall be placed in 8-inch-thick lifts.
- H. Select Fill shall be compacted to not less than 95 percent of the maximum dry density obtainable by ASTM D 698 and does not contain unsuitable material.
- I. Select Fill shall be compacted at a moisture content within 20 percent of the optimum moisture content of the fill material in accordance with the ASTM D 698, Standard Proctor.
- J. All materials used as Select Fill are subject to approval by the Engineer.

2.03 DRAINAGE FILL

- A. Drainage Fill shall be used where shown on the Contract Drawings.

2.04 COMMON FILL

- A. Common Fill shall be used where shown on the Contract Drawings.
- B. Common Fill shall consist of non-organic on-site soils classifying as CH, MH, CL, ML, SC, SM, SP, SW, GC, GM, GP, or GW according to ASTM D 2487.
- C. Common Fill shall be placed in 8-inch-thick loose lifts.
- D. Common Fill shall be compacted to not less than 95 percent of the maximum dry density obtainable by ASTM D 698 and does not contain unsuitable material.
- E. Common Fill shall be compacted at a moisture content within 20 percent of the optimum moisture content of the fill material in accordance with the ASTM D 698, Standard Proctor.
- F. All material used as common fill is subject to approval by the Engineer. If there is insufficient suitable material onsite, import whatever additional material is required which conforms to the specifications, at no additional cost to the Owner.
- G. Select Fill may be used as Common Fill, subject to approval by the Engineer. Select fill may be used as Common Fill at no change in the Contract Price.

2.05 TOPSOIL

- A. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). It shall be free of debris, trash, stumps, rocks, roots, and noxious weeds, and shall give evidence of being able to support healthy vegetation. It shall contain no substance potentially toxic to plant growth.
- B. All topsoil shall be tested before use on site by a recognized laboratory for the following criteria according to local standards (or at a minimum according to ASTM D5268-22, Table 1): Organic matter content shall not be less than 3% by weight. pH range shall be from 5.5 -7.5. If pH is less than 5.5, lime shall be added in accordance with test results or in accordance with the recommendations of the vegetative establishment practice being used. Soluble salts shall not exceed 2.5 mmhos/cm ppm. If additional topsoil is needed, it must meet the standards stated above.
- C. Soils falling within the ranges of ASTM D5268-22, Table 1 shall form a suitable topsoil. Soils being used as a topsoil with organic content matter contents between 10% and 90% may need to be amended prior to use. If soils proposed for use as topsoil do not meet the criteria of Table 1, an engineered soil amendment may be added to meet the

requirements. When using an engineered soil amendment, the organic matter values need to be greater than 75%.

PART 3 – EXECUTION

3.01 STRIPPING OF TOPSOIL

- A. In all areas to be excavated, filled, or paved, the topsoil shall be stripped to its full depth.
- B. Topsoil may be stockpiled for subsequent reuse on site at locations shown on the Contract Drawings or designated by the Owner or Engineer. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials. Topsoil shall not be stored in areas where it will interfere with surface drainage or with the conservation of trees, shrubs, and other vegetation to remain. No stockpile shall be placed within 50-feet of a pond, stream, wetland, or stormwater inlet.

3.02 EXCAVATION

- A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, all other obstacles encountered, and all other obstacles shown to be removed within the limits of excavation shown on the Contract Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.
- B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER AND/OR MATERIALS TESTING CONSULTANT WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off-site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer and/or materials testing consultant such measures are necessary to provide proper construction.
- C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.

- D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings.
- E. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes.
- F. It is the intent of these Specifications that all structures shall bear on an aggregate base, crushed stone or screened gravel bedding placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as specified in Section 40 05 00 – Basic Mechanical Requirements, or as shown on the Drawings.
- G. The bottom of all excavations for structures and pipes shall be examined by the Engineer and/or materials testing consultant for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer and/or materials testing consultant, additional excavation is required due to the low bearing value of the subgrade material, or if the in place soils are soft, yielding, pumping or wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by the Engineer shall be made as an extra by a Change Order in accordance with the General Conditions and Division 01, General Requirements. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.
- H. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.
- I. Slides and over-breaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Engineer at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.
- J. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a

minimum of 6 inches and a maximum of 24-inches of Common fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Engineer for this purpose.

3.03 EXCAVATION SUPPORT

- A. The Contractor shall furnish, place, and maintain such excavation support which may be required to provide safe working conditions and support sides of excavation or to protect structures, pipes, and utilities from possible damage. The Contractor shall be exclusively responsible for maintaining safe working conditions and structure integrity without overstressing or damaging existing structures, pipes, and utilities resulting from the Contractor temporarily placing, moving, or removing loads on or adjacent to existing structures, pipes, and utilities. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, the Engineer may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing the support system.
- B. The selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations to the Engineer on the proposed systems sealed by a Professional Engineer currently registered in the in the State or Commonwealth in which the project is located.
- C. The excavation support system shall be installed by a specialized contactor with a minimum of five (5) years' experience installing the type of excavation support system proposed.
- D. The Contractor shall exercise caution in the installation and removal of supports to ensure no excessive or unusual loadings or vibrations are transmitted to any new or existing structure. The Contractor shall promptly repair at their expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.
- E. Contractor shall monitor movement and vibration in the excavation support systems as well as movement and vibration at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. The Contractor shall be exclusively responsible for repair of any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of their operations.
- F. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and

expense of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 01, General Requirements. Vibrations of new and existing structures shall be considered when the Contractor decides whether to remove excavation supports or leave them in place. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

3.04 PROTECTION OF SUBGRADE

- A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:
 - 1. Use of heavy rubber tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.
 - 2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.
 - 3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

3.05 PROOF-ROLLING

- A. The subgrade of all structures and all areas that will support pavements or select fill shall be proof-rolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proof-rolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material, as directed by the Materials Consultant.

3.06 DEWATERING

- A. The Contractor shall do all dewatering as required for the completion of the work. Procedures for dewatering proposed by the Contractor shall be submitted to the Engineer for review prior to any earthwork operations.

- B. The dewatering system shall be of sufficient size and capacity as required to control groundwater or seepage to permit proper excavation operations, embankment construction and reconstruction, subgrade preparation, and to allow concrete to be placed in a dry condition. The system shall include a sump system or other equipment, appurtenances and other related earthwork necessary for the required control of water. The Contractor shall drawdown groundwater to at least 2 feet below the bottom of excavations (subgrade), over the entire tempo, at all times in order to maintain a dry and undisturbed condition.
- C. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled, and its disposal provided for at each berm, structure, etc. The entire periphery of the excavation areas shall be ditched and diked to prevent water from entering the excavation. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.
- D. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by their failure to maintain and operate the dewatering system proposed and installed by the Contractor.
- E. The Contractor shall be responsible for and shall repair, without cost to the Owner, any damage to work in place and nearby structures, roadways, and utilities which can be reasonably attributed to dewatering operations. This includes settlement of structures, roadways, and utilities due to dewatering of soils supporting the structures, roadways, and utilities.
- F. The Contractor shall take all the steps that they consider necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the dewatering systems will not erode, deteriorate, or clog to the extent that the dewatering systems will not perform properly during the period of dewatering. Copies of logs of borings and laboratory test results are available to the Contractor. This data is furnished for information only, and it is expressly understood that the Owner and Engineer will not be held responsible for any interpretations or conclusions drawn therefrom by the Contractor.
- G. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.07 FILL OR EMBANKMENTS

- A. Contractor shall perform the construction of fill or embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.
- B. Subgrades upon which fill or embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing fill or embankment material, the Contractor shall compact the top 12 inches of in place soil as specified under Paragraph 3.09, COMPACTION.
- C. Any soft or unsuitable materials revealed before or during placement fill or embankment placement shall be removed as indicated by the Engineer and/or materials testing consultant and replaced with select fill and compacted as required.
- D. Fill subgrades on which fill or embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The fill or embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers. The loose thickness of each lift shall not exceed the thickness for each fill type noted in Paragraph 3.09, COMPACTION.
- E. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. Fill or embankment subgrades shall be properly drained at all times and kept free of flowing or ponding water, snow, ice and frozen soils. Saturated soils, snow, ice, or frozen soils shall be removed as recommended by the Engineer.
- F. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.09, COMPACTION.
- G. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Moisture conditions and manipulation of the fill or embankment material, when necessary, shall be performed to maintain a uniform moisture content throughout the layer. Should the material be too wet or too dry to permit proper compaction, earthwork operations shall be delayed until the material is adequately moisture conditioned. Samples of all fill or embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.
- H. Where fill or embankments materials are to be placed and compacted on sloped subgrades steeper than 4:1 shall be benched. Benches shall be at least 6-feet wide.
- I. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the

other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4 inches in their greatest dimension will not be allowed within the top 6 inches of the final grade. Stones, fragmentary rock, or boulders larger than 12 inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

3.08 BACKFILLING

- A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Fill placed as structure or utility backfill shall be deposited in successive, uniform, approximately horizontal lifts. The thickness of each lift shall not exceed the requirements of Paragraph 3.09, COMPACTION.
- B. Each lift of fill placed backfill shall be thoroughly compacted to the density specified for each type of fill included in Paragraph 3.09, COMPACTION.
- C. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.
- D. Backfill against concrete or masonry structure shall not be performed until the Work has been reviewed and backfilling permitted. Backfill against walls shall also be deferred until the structural slab for floors above the top fill line have been placed and attained design strength or earlier at the discretion of the Engineer. Partial backfilling against adequately braced wall may be considered by the Engineer on an individual situation basis. Where walls are to be waterproofed, all Work shall be completed and membrane materials dried or cured according to the manufacturer's instructions before backfilling.
- E. Backfill against tanks and other structures which are to retain liquids shall not be performed until leakage tests are completed and accepted by the Engineer in accordance with the Section entitled "Water Tightness Testing".

3.09 COMPACTION

- A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

B. Compaction Near Existing Structures

	Density % Standard Proctor (D 698)	Density % Mod. Proctor (D 1557)	Max. Lift Thickness as Compacted Inches
Embankments Beneath Structures, Roadways, and Sidewalks*	98	92	8
Common Fill Areas	95	90	8
Backfill Around Structures	95	90	8
Backfill in Pipe Trenches	95	90	8
Crushed Stone Beneath Structures	**	**	12
Select Sand	98	92	8
Aggregate Base Course (ABC) Beneath Structures, Roadways, and Sidewalks	**	**	8
Crushed Stone Backfill	**	**	12
Crushed Stone Pipe Bedding	**	**	12
In Place Subgrade Beneath Structures, Roadways, and Sidewalks	98	92	Top 12-inches

* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope.

** The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

1. Vibratory equipment shall not be used within 25 feet of any existing structure.
2. Within 25 feet of any existing structure, non-vibratory compaction equipment such as a drum roller with a maximum weight of 4 tons should be used. Within 5 feet of any existing structure, a walk behind vibratory sled or roller shall be used.

C. Field density tests will be made by the Materials Testing Consultant to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 1557, or ASTM D 6938. The Engineer, in conjunction with the Materials Testing Consultant, will be the judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to recompact the material or remove it as required. The Contractor shall, if necessary, increase the compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.

- D. Testing will be performed as frequently as deemed necessary by the Engineer and/or Materials Testing Consultant. As a minimum, one in place density test shall be performed for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either or as directed by the Engineer or recommended by Material Testing Consultant.

3.10 VIBRATION MONITORING

- A. Vibration monitoring shall be performed at nearby structures when compaction work is ongoing. A single monitoring point using vibration monitoring equipment capable of detecting velocities of 0.1 inch/second or less and survey measurements shall be used for vibration monitoring at each of the nearest structures. An elevation measurement on nearby structures shall be taken before compaction work starts, and then at least twice a day during the work with one reading taken at the conclusion of the day's operations. Elevation measurements shall be recorded to an accuracy of 0.005 foot. If at any time the Contractor detects settlement or heave of 0.005-feet or more, or vibration levels of 1.0 inch/second or more, the vibratory compaction shall be stopped immediately, and the Engineer notified.

3.11 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

- A. The Contractor shall remove and dispose of off-site all excess and unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.
- B. All excess and unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state/commonwealth and local laws and regulations.
- C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.
- D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.
- E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

3.12 BORROW EXCAVATION

- A. Description
 - 1. The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on

the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

2. Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfilling and incorporated into the embankments.

B. Coordination with Seeding Operations

1. The Contractor shall coordinate the work covered by this section with the construction of embankments and area fill so the requirements of Section 32 90 00 – Final Grading and Landscaping are met.

C. Borrow Materials

1. All material shall meet the requirements of Part 2 for Select Fill or shall meet the requirements of Common Fill and classify as SM or coarser according to ASTM D 2487.

D. Construction Methods

1. General

- a. The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 31 10 00 – Clearing, Grubbing, and Site Preparation.
- b. Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control measures as may be approved by the Engineer.
- c. The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as necessary to prevent the erosion of the stockpile material. Once all borrow material has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.
- d. Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct hauling operations in such a manner as to not interfere with the normal flow of traffic and shall always keep the traffic lanes free from spillage.

2. Owner Furnished Sources

- a. Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.
- b. The Owner will furnish the necessary haul road right-of-way at locations designated by the Engineer. All haul roads required shall be built, maintained, and when directed by the Engineer, obliterated, at no cost to the Owner. Where the haul road is to be reclaimed for cultivation the Contractor shall plow or scarify the area to a minimum depth of 8 inches, or to the depth requested by the property owner.
- c. The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand, and a functioning drainage system shall be provided.
- d. All sources shall be seeded and mulched in accordance with Section 32 90 00 – Final Grading and Landscaping.

3. Contractor Furnished Sources

- a. Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State/Commonwealth Historic Preservation Officer of the State/Commonwealth Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Engineer prior to performing any work on the proposed borrow source.
- b. The approval of borrow sources furnished by the Contractor shall be subject to the following conditions:
 - 1) The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.
 - a) Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

- 2) The Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Engineer, as described in Paragraph 1.05, for approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary.

4. Maintenance

- a. During construction and until final acceptance the Contractor shall use any methods approved by the Engineer which are necessary to maintain the work covered by this Section so that the work will not contribute to excessive soil erosion.

END OF SECTION

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SECTION 31 05 16
AGGREGATE MATERIALS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and materials required to complete all work associated with the installation of aggregate material beneath foundations, as backfill and as roadway subgrades and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 42 00 – References
- B. Section 31 00 01 – Earthwork
- C. Section 31 25 00 – Erosion and Sedimentation Control
- D. Section 32 10 00 – Paving and Surfacing
- E. Section 32 90 00 – Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. Utah Department of Transportation Standard Specifications and Standard Drawings.
 - 2. ASTM C 127 – Test for Specific Gravity and Absorption of Coarse Aggregate.
 - 3. ASTM C 136 – Test for Sieve Analysis of Fine and Coarse Aggregates.
 - 4. ASTM C 535 – Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Materials gradation and certification.
 - 2. ASTM C127, ASTM C136, and ASTM C535 test results

PART 2 – PRODUCTS

2.01 CRUSHED STONE, SCREENED GRAVEL AND AGGREGATE BASE COURSE (ABC)

- A.
- B. ABC shall meet the requirements of ABC as defined by Utah Department of Standard Specifications and Standard Drawings.

PART 3 – EXECUTION

3.01 CRUSHED STONE, SCREENED GRAVEL AND AGGREGATE BASE COURSE (ABC)

- A. Contractor shall install crushed stone, screened gravel and ABC in accordance with the Utah Department of Standard Specifications and Standard Drawings and as shown on the Drawings and indicated in the Contract Documents.
 - 1. Unless otherwise stated herein or shown on the Drawings, all mat foundations (bottom slabs) for the proposed structures shall have a blanket of crushed stone or ABC 6-inches thick minimum placed directly beneath the proposed mat. The blanket shall extend a minimum of 12 inches beyond the extremities of the mat.
 - 2. For subgrade preparation at structures and structural fill, the foundation material shall be ABC where specifically specified on Drawings, otherwise, crushed stone or screened gravel shall be used.

3.02 SELECT SAND

- A. Contractor shall install select sand in accordance with the Utah Department of Standard Specifications and Standard Drawings and as shown on the Drawings and indicated in the Contract Documents.

END OF SECTION

SECTION 31 10 00
CLEARING, GRUBBING, AND SITE PREPARATION

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.

- B. Principal items of work include:
 - 1. Notifying all authorities owning utility lines running to or on the property. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.
 - 2. Clearing the site within the Contract Limit Lines, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.
 - 3. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved. Relocating trees and shrubs, so indicated on the Drawings, to designated areas.
 - 4. Repairing all injury to trees, shrubs, and other plants caused by site preparation operations shall be repaired immediately. Work shall be done by qualified personnel in accordance with standard horticultural practice and as approved by the Engineer.
 - 5. Removing topsoil to its full depth from designated areas and stockpiling on site where directed by the Engineer for future use.
 - 6. Disposing from the site all debris resulting from work under this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 00 01 – Earthwork
- B. Section 31 25 00 – Erosion and Sedimentation Control

1.03 STREET AND ROAD BLOCKAGE

- A. Closing of streets and roads during progress of the work shall be in compliance with the requirements of the Owner and other authorities having jurisdiction. Access shall be provided to all facilities remaining in operation.

1.04 PROTECTION OF PERSONS AND PROPERTY

- A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.
- B. All conduits, wires, cables and appurtenances above or below ground shall be protected from damage.
- C. Provide warning and barrier fence where shown on the Drawings and as specified herein.

PART 2 – EXECUTION

2.01 CLEARING OF SITE

- A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.
- B. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Prior to the start of construction, the Contractor shall survey the entire Contract site and shall prepare a plan which defines the areas to be cleared and grubbed, trees to be pruned, extent of tree pruning, and/or areas which are to be cleared but not grubbed. This plan shall be submitted to the Engineer for approval. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.
- C. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 31 00 01 – Earthwork.
- D. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15-ft. wide along all permanent fence lines installed under this Contract.
- E. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in their opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2.02 STRIPPING AND STOCKPILING EXISTING TOPSOIL

- A. Erosion and sedimentation control measures shall be installed as per the Federal, State or Locally approved Erosion and Sedimentation Control Plan for the project and

Specification Section 31 25 00 – Erosion and Sedimentation Control before any stripping and stockpiling of topsoil can occur.

- B. Existing topsoil and sod on the site within areas designated on the Drawings shall be stripped to whatever depth it may occur and stored in locations directed by the Engineer.
- C. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil.
- D. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

2.03 GRUBBING

- A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.
- B. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

2.04 DISPOSAL OF MATERIAL

- A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.
- B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

2.05 WARNING AND BARRIER FENCE

- A. The fence shall be made of a visible, lightweight, flexible, high strength polyethylene material. The fence shall be Guardian Visual Barrier as manufactured by TEMAX, or equal.
- B. Physical Properties

Fence	
Color	International Orange
Roll Size	4' x 100'
Roll weight	9 lbs.
Mesh opening	1-3/4" x 1-3/4"
Posts	
ASTM Designation:	ASTM 702

Length:	6 feet long (T-Type)
Weight:	1.25 #/Foot (min)
Area of Anchor Plate:	14 Sq. In.

- C. Drive posts 18 inches into ground every 8'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.

- D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

END OF SECTION

SECTION 31 23 25
DYNAMIC COMPACTION

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, equipment and materials required to complete all work associated with dynamic compaction required for the in-place densification of the subgrade soils as indicated on the Drawings. The effect of the process shall create a known and verifiable, uniform condition and a subgrade soil bearing capacity of at least 3500 psf, which limits total settlement to 1-inch and differential settlements to 1/2-inch.
- B. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the Utah Department of Transportation Standard Specifications and Standard Drawings.

1.02 RELATED SECTIONS

- A. Requirements of related work are included in Division 01 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The current editions and addenda of the following publications are made part of the Specifications and are applicable to the extent indicated by the specific reference. Testing performed shall conform to the following applicable standards:
 - 1. Utah Department of Transportation Standard Specifications and Standard Drawings.
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM D2049 – Test Method for Relative Density of Cohesionless Soils.
 - b. ASTM D2167 – Test for Density of Soil in Place by the Rubber-Balloon Method.
 - c. ASTM D2922 – Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 SUBSURFACE CONDITIONS

- A. Information on subsurface conditions is referenced under Division 01, General Requirements.

- B. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed dynamic compaction. Perform all repairs to same in the event that excavation activities disrupt service.

1.05 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, the Contractor shall submit the following:
 - 1. Name and qualification of specialty subcontractor performing dynamic compaction.
 - 2. Name and qualification of geotechnical engineer who will monitor dynamic compaction, provide supervision of the operation and perform required testing to substantiate compaction results.
 - 3. Program and plan to monitor vibrations associated with dynamic compaction operations.
 - 4. Work plan for dynamic compaction.

1.06 CONTRACTOR'S QUALIFICATIONS

- A. The Contractor shall obtain the services of an approved specialty subcontractor who is regularly engaged and experienced in dynamic compaction work. The subcontractor shall have at least five (5) years of experience in performing dynamic compaction and have completed at least fifteen (15) projects of similar scope, difficulty, and comparable size.
- B. The Contractor or specialty subcontractor shall have on his staff or shall obtain the services of a geotechnical engineer to provide constant field supervision to monitor and record daily activities and performance of work. The geotechnical engineer shall perform appropriate tests to determine the depth of compaction and density of the subgrade soils prior to excavation operations in advance of final subgrade preparations.
- C. The specialty subcontractor and geotechnical engineer shall be approved by the Engineer prior to construction. Engineer's approval will be based on the minimum experience criteria designated herein.

PART 2 – EXECUTION

- A. Following clearing and topsoil stripping operations, the site shall be graded at a grade not exceeding 4 percent.
- B. Dynamic Compaction shall be performed over the designated area utilizing a crane suitably powered and dimensioned for the work. The crane's mechanism shall allow a

weight (pounder) to free fall from a height of 50 to 60 feet impacting the earth with high compactive energy. A minimum weight of 10 tons shall be used. The number of drops per impact point shall be field determined after performing initial drops. A minimum of 6 drops per impact point shall be performed, unless conditions and acceptable results allow fewer drops. The geotechnical engineer shall constantly monitor the operation recommending modifications as necessary. The spacing of drops shall be established in a square pattern over the entire area. The spacing shall be no more than 8 feet unless approved otherwise by the Engineer. Multiple passes may be required to apply the total energy necessary to achieve the specified compaction results.

- C. After the dynamic compaction operation is complete and the densities of the subgrade soils have been determined to be satisfactory, the grading and excavation of the site shall proceed which will include cut and fill placement to fill the craters created by the dynamic compaction operation and to reach the specified subgrades. Excavation and embankment operations shall be performed in accordance with Section 31 00 01 – Earthwork. Placement of structural fill and select fill shall be as indicated on the Drawings. If the required densification of the deeper soils has not be attained as determined by the Engineer after the site has been graded to the required subgrade elevations, the Contractor shall perform additional compaction procedures acceptable to the Engineer at no additional cost to the Owner.
- D. The Contractor shall furnish the Engineer a technical work plan two weeks prior to the start of the operation indicating his proposed plan to dynamically compact the subgrade soils. The submittal shall include crane data, proposed weight (pounder), drop height, impact spacing, number of passes and work sequence.
- E. The Contractor shall be responsible to monitor the site to document vibrations leaving the site during the dynamic compaction operation. Vibrations shall be monitored utilizing a seismograph capable of providing a record of particle velocity along three mutually perpendicular axes utilizing internal calibration. A pre-construction condition inspection and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. The Contractor shall exercise the utmost care not to damage property on-site and off-site. The Contractor shall notify each adjoining property owner within 500 yards of the proposed work of the anticipated vibrations and noise which will occur due to his operation. This notice shall be given sufficiently in advance to enable the adjacent property owners to take whatever precautions they may consider necessary. The Contractor shall limit his operations to minimize any disturbance to the adjacent property owners if necessary. The Contractor shall be responsible for any damage to any structure or utility line, pipes, etc., on-site and off-site as a result of his operations.

PART 3 – NOT USED

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SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.01 THE REQUIREMENTS

- A. The Contractor is responsible for implementing Stormwater Control Measures (SCMs) to prevent and minimize erosion and resultant sedimentation in all cleared and grubbed areas during and after construction. This item covers the work necessary for the installation of structures and measures for the prevention of soil erosion and control of sedimentation. The Contractor shall furnish all material, labor and equipment necessary for the proper installation, maintenance, inspection, monitoring, reporting, and removal (where applicable) of erosion prevention and sediment control measures and, if applicable, to cause compliance with all local permits, for any land disturbance or construction activity of one (1) acre or more, under this Section 31 25 00 – Erosion and Sedimentation Control.
- B. Any land disturbance as the result of modifications to a site's drainage features or topography requires protection from erosion and sedimentation.
- C. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Contract Drawings or established by the Engineer.
- D. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.
- E. The following excerpts from the regulations are particularly important:
 - 1. All other slopes of 3H: 1V or flatter, except those with slopes greater than 50 feet in length or within HWQ Zones, following completion of any phase of grading, shall be planted or otherwise provided with temporary or permanent ground cover, devices, or structures sufficient to restrain erosion within 14 calendar days.
- F. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sediment control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Contract Drawings shall have the prior acceptance of the Engineer and shall be completed at no additional cost to the Owner.

04/16/12

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 – Submittal Procedures

- B. Section 31 10 00 – Clearing, Grubbing, and Site Preparation
- C. Section 31 00 10 – Earthwork
- D. Section 32 11 00 – Surface Restoration
- E. Section 32 90 00 – Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.
- B. See Specification Section 01 42 00 – References.

1.04 REGULATORY COMPLIANCE

- A. Land disturbance activities are not authorized to begin until after all required erosion and sediment control permits are obtained from the United States, the State of Utah and local authorities, as necessary. Contractor is the Co-Primary Permittee and Operator under the provisions of the NPDES Permit. As such, the Contractor will be required to sign certain certifications as described in the NPDES Permit. Contractor shall comply with requirements specified in the Contract Documents, on the approved Erosion Control Plan, and by the Engineer. Contractor shall also comply with all other laws, rules, regulations, ordinances and requirements concerning soil erosion and sediment control established in the United States, the State of Utah and local authorities as applicable.
- B. During the period beginning on the effective date of the permit and lasting until expiration, the Permittee is authorized to discharge stormwater associated with construction activity including clearing, grading and excavation activities resulting in the disturbance of land and related support activities. Such discharges shall be controlled, limited and monitored as specified below.
 - 1. The Contractor, as Co-Primary Permittee and Operator under the provisions of the NPDES Permit, shall submit a plan for compliance with the Owner-provided approved erosion and sedimentation control plan to the Engineer for approval. Plans must include designation of where 7 and 14-day ground stabilization requirements and where basins which comply with surface-withdrawal requirements of the NPDES permit, if applicable, are located. Land disturbing activity shall not commence until the plan is approved by the Engineer. Maintain an up-to-date copy of the approved plan on the site.
 - 2. Implement the approved plan. Deviation from the plan is allowed only to correct emergency situations of sediment discharge offsite or when minor modifications are made to improve performance of the measures and the approval authority has been notified. Note allowed deviations on the plan maintained on the site.
 - 3. Manage onsite activities such that no adverse impacts to water quality occur from site activities or allowed discharges. The following activities, and others on a site-specific basis, require oversight

throughout the construction and development process to assure that all water quality standards are protected.

- a. **Equipment Operation and Maintenance:** Equipment utilized during the construction activity on a site must be operated and maintained in such a manner as to prevent the potential or actual pollution of the surface or ground waters of the State. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not be discharged onto the ground or into surface waters. Spent fluids shall be disposed of in a manner so as not to enter the waters, surface or ground, of the State and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in a manner so as not to allow their entry into the waters, surface or ground, of the State.
- b. **Material Handling:** Herbicide, pesticide, and fertilizer usage during the construction activity shall be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act and shall be in accordance with label restrictions.
- c. **Building Material Waste Handling:** In particular, the following guidelines shall be followed:
 - 1) No paint or liquid wastes in streams or storm drains.
 - 2) Dedicated area for demolition, construction, and other wastes must be located a minimum of 50' from storm drains and streams unless no reasonable alternatives are available.
 - 3) Earthen-material stockpiles must be located a minimum of 50' from storm drains and streams unless no reasonable alternatives are available.
 - 4) Concrete materials onsite, including excess concrete, must be controlled to avoid contact with surface waters, wetlands, or buffers. (Note discharges from onsite concrete plants may require coverage under a separate NPDES permit – NCG140000).
- d. **Litter and Sanitary Waste:** The Permittee shall control the management and disposal of litter and sanitary waste from the site.

C. Violations and Fines

1. Contractor shall be responsible for reimbursing the Owner for any fines incurred as a result of violations.
2. If violations result in the issuance of a Notice of Violation, the Contractor shall comply with the requirements of the Notice within the specified time period for compliance. Failure to comply could result in the assessment of a penalty for each day of the continuing violation, beginning with the date of the violation.
3. Violations may result in civil and/or criminal penalties which include fines and imprisonment.

1.05 SUBMITTALS

- A. Prior to the start of the work, the Contractor shall prepare and submit a plan for implementing the temporary and permanent erosion and sedimentation control measures as shown on the Erosion and Sediment Control Plan approved by the appropriate regulatory authority. Construction work shall not commence until the schedule of work and the methods of operations have been reviewed and approved.
- B. The Contractor shall perform inspections of erosion and sedimentation control measures and stormwater discharge outfalls and prepare inspection reports as described in Part 3.0 of this Section. Copies of the inspection reports shall be submitted to the Engineer on a monthly basis.
- C. In accordance with the procedures and requirements set forth in the General Conditions Division 01 and Section 01 33 00 – Submittal Procedures, the Contractor shall submit the following:
 - 1. Name and location of all material suppliers.
 - 2. Certificate of compliance with the standards specified above for each source of each material.
 - 3. List of disposal sites for waste and unsuitable materials and evidence of all required permits for use of those sites.

1.06 GUARANTEE

- A. All restoration and re-vegetation work shall be subject to the one-year guarantee period of the Contract as specified in the General Conditions.

PART 2 – MATERIALS

2.01 MATERIALS

- A. All erosion and sediment control bid prices shall include all excavation, grading, maintenance, legal sediment disposal, permits and all other work and appurtenances necessary to design, install and maintain the sediment and erosion control measures as detailed herein.

2.02 SILT FENCE

- A. Silt (or sediment) fence shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Silt fences shall be installed below small disturbed areas that are less than $\frac{1}{4}$ acre disturbed per 100-feet of fence when slopes are less than 2%. Silt fence shall not be installed across streams, ditches, or waterways or other areas of concentrated flows.
- B. Silt fence shall be designed, installed and maintained in accordance with Part 3.0 of this Section. Silt fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalines and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be C-50NW as manufactured by Contech Earth Stabilization Solutions, GT 142 as manufactured by SKAPS Industries, Soiltex ST 120N as

manufactured by Geo-Synthetics, Inc., or approved equal. The cost of silt fence shall include the materials, excavation, backfill, aggregate, periodic sediment removal, etc. and all maintenance and restoration activities required.

C. Silt fence shall be stable for the 10-year peak storm runoff. Fabric shall meet the following specifications:

Temporary Silt Fence Material Property Requirements

	Test Material	Units	Supported¹ Silt Fence	Un-Supported¹ Silt Fence	Type of Value
Grab Strength	ASTM D 4632	N (lbs)			
Machine Direction			400	550	MARV
			(90)	(90)	
x-Machine Direction			400	450	MARV
			(90)	(90)	
Permittivity ²	ASTM D 4491	sec-1	0.05	0.05	MARV
Apparent Opening Size 2	ASTM D 4751	mm	0.60	0.60	Max. ARV ³
		(US Sieve #)	(30)	(30)	
Ultraviolet Stability	ASTM D 4355	% Retained Strength	70% after 500 hours exposure	70% after 500 hours exposure	Typical

Notes:

- 1 Silt Fence support shall consist of 14 gage steel wire with a mesh spacing of 150 mm (6 inches), or prefabricated polymer mesh of equivalent strength.
- 2 These default values are based on empirical evidence with a variety of sediment. For environmentally sensitive areas, a review of previous experience and/or site or regionally specific geotextile tests in accordance with Test Method D 5141 should be performed by the agency to confirm suitability of these requirements.
- 3 As measured in accordance with Test Method D 4632.

- D. The synthetic filter fabric shall consist of at least 95% by weight of polyolefins or polyester, as certified by the manufacturer.
- E. The posts for silt fences shall be 1.33 lb/linear feet steel with a minimum length of 5 feet; posts shall have projections to facilitate fastening of the fabric.
- F. For reinforcement of standard strength filter fabric use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.

2.03 STONE FOR EROSION CONTROL

- A. The Contractor shall place stone for erosion control as shown on the Contract Drawings, and as specified herein. The stone for erosion control shall consist of field stone or rough un-hewn quarry stone. The stone shall be sound, tough, dense, and resistant to the action of air and water.
- B. Stone for erosion control shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost for stone for erosion control shall include furnishing, weighing, stockpiling, re-handling, placing and maintaining stone; disposal of any stone not incorporated into the project if directed by the Engineer; and any other incidentals necessary to complete the work.

2.04 RIP RAP

- A. The Contractor shall place rip rap as shown on the Contract Drawings. The stone for rip rap shall consist of field stone or rough un-hewn quarry stone. The rip rap shall be sound, tough, dense, and resistant to the action of air and water. Neither the width nor thickness of individual stones shall be less than one third their length. Rip rap shall be designed, installed, and maintained in accordance with Part 3.0 of this Section. The cost for rip rap shall include furnishing, weighing, stockpiling, rehandling, placing, and maintaining rip rap; disposal of any rip rap not incorporated into the project if directed by the Engineer; geotextile material and installation, and all other incidentals necessary to complete the work.

2.05 ROLLED EROSION CONTROL (RECM) AND TURF REINFORCEMENT MAT (TRM)

- A. Rolled Erosion Control Mat (RECM), and Turf Reinforcement Mat (TRM), shall be installed as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. RECMs should be utilized to aid stabilization of slopes greater than 2:1 and with more than 10 feet of vertical relief. RECMs should also be used when mulch cannot be adequately tacked and where immediate ground cover is required to prevent erosion damage. Examples of RECMs are blankets, nets and matting.
- B. RECM's utilizing plastic netting of any type – polypropylene, nylon, polyethylene, and polyester - shall not be used, including plastic netting designated as degradable, photodegradable, UV-degradable, oxo-degradable, or oxo-biodegradable. Use loose weave, non-welded, movable jointed netting (leno or gauze). Rectangle (elongated) mesh is preferred over square mesh.
- C. RECMs shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost for RECMs shall include all excavation, grading, and materials, and all maintenance activities.
- D. RECMs shall be used to aid in stabilization of vegetated channels where runoff velocity will exceed 2 feet/second on bare earth during the 2-year rainfall event that produces peak runoff.
- E. Typically, nets shall be used in conjunction with mulch; the use of mulch is typically not required with excelsior, woven straw blankets and coir blankets.
- F. The recommended anchoring devices are 12-inch minimum length wooden stakes, or rigid, 100% biodegradable stakes of a minimum of 6 inches in length. If Manufacturer's recommendations are more stringent, they shall supersede.

- G. The minimum tensile strength and bare soil shear stress values for specific RECMs are as follows:
1. Straw with net temporary RECM shall be North American Green BioNet S75BN, American Excelsior Co. Curlex I FibreNet, East Coast Erosion Control ECS-1B, or equal with a minimum tensile strength of 100 lbs/ft and minimum bare soil shear stress value of 1.5 lb/ft².
 2. Curled wood or coconut fiber RECM shall be American Excelsior Curlex II FibreNet, North American Green BioNet C125BN, East Coast Erosion Control ECC-2B, or equal matting with a minimum tensile strength of 140 lbs/ft and a minimum bare soil shear stress value of 2.0 lb/ft².
 3. Synthetic Turf Reinforcement Mat (TRM) shall be High Performance (HPTRM) woven products with continuous yarns woven into a tight, three-dimensional matrix with opening sizes less than 5 mm. HPTRM's shall be Propex Geosolutions Pyramat, North American Green TMax®, Nilex PP5-Xtreme, or equal matting with a minimum tensile strength of 3000 lbs/ft and a long-term vegetated shear stress value of 15.0 lb/ft².
- H. The cost of RECM and TRM shall include the mat and anchoring materials, installation, and all maintenance activities required.

2.06 TEMPORARY AND PERMANENT DIVERSIONS

- A. Temporary diversions shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Permanent diversions shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Temporary diversions shall be constructed adjacent to disturbed areas to collect surface runoff from disturbed areas and direct the runoff to sediment basins or to divert non-sediment laden runoff away from undisturbed areas and/or sediment basins. All temporary diversions transporting sediment-laden runoff shall terminate in a sediment trapping device. Permanent diversions should be planned as a part of initial site development and should be coordinated with temporary diversions. All temporary and permanent diversions shall be stabilized with vegetation or other means within 7 days of installation. Permanent diversions shall be used to divert water to locations where it can be used or released without erosion or flood damage. Dimensions shall be as shown on the Contract Drawings.
- B. Temporary diversions shall be designed, installed and maintained in accordance with Part 3.0 of this Section, to the satisfaction of the Engineer, until the site has been stabilized. Permanent diversions shall be designed, installed and maintained in accordance with Part 3.0 of this Section . The cost of temporary and permanent diversions shall include the excavation, grading, materials, etc. and all maintenance and restoration activities required.

2.07 TEMPORARY SLOPE DRAINS

- A. Temporary slope drains shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Temporary slope drains are used to convey concentrated runoff down the face of a slope without causing erosion and are generally used in conjunction with temporary diversions.

- B. The pipe shall be heavy-duty flexible material such as non-perforated, corrugated plastic pipe or specially designed flexible tubing.
- C. Temporary slope drains shall be designed, installed and maintained in accordance with Part 3.0 of this Section, to the satisfaction of the Engineer, until the site has been stabilized. The cost of the temporary slope drains shall include the piping, earthwork, stone for erosion control, and all maintenance activities required. Temporary slopes drains shall be removed from site and the materials disposed of in an approved manner once final stabilization has been achieved.

2.08 TEMPORARY GRAVEL CONSTRUCTION ENTRANCES/EXITS

- A. Temporary gravel construction entrances/exits shall be located at points where vehicles enter and leave a construction site, at other locations indicated by the Engineer, and as specified herein.
- B. Temporary gravel construction entrances/exits shall be constructed with a minimum 6-inch layer of 2 – 3 inch washed stone placed over a stable foundation and shall be a minimum of 100 feet in length and 25 feet in width. Geotextile fabric shall be used under stone as shown on the Contract Drawings.
- C. Temporary gravel construction entrances/exits shall be designed, installed and maintained in accordance with Part 3.0 of this Section, to the satisfaction of the Engineer, until the site has been stabilized. The cost of temporary gravel construction entrances/exits shall include the materials, including the application of additional stone, tire washing, and other maintenance as may be necessary. Temporary gravel construction entrances/exits shall be removed from site and the materials disposed of in an approved manner once final stabilization has been achieved.

2.09 TEMPORARY AND PERMANENT STABILIZATION OF DISTURBED AREAS

- A. Temporary and permanent stabilization of disturbed areas will be provided at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein,. The Contractor shall provide ground cover adequate to restrain erosion on disturbed areas that will be left un-worked for periods exceeding 7 to 14 days, as noted in Paragraph 1.01. F. of this Specification.
- B. Temporary soil stabilizer shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.
- C. Temporary and permanent stabilization of disturbed areas shall be achieved in accordance with Part 3.0 of this Section. The cost of temporary and permanent stabilization of disturbed areas shall include all grading, excavation, materials, and all reseeding and other maintenance activities required until stabilization is achieved.

2.10 CHECK DAMS AND CHECK DAMS WITH WEIRS

- A. Check dams shall be constructed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Check dams with weirs shall be constructed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.
- B. Check dams and check dams with weirs shall not be constructed in an intermittent or perennial stream. The drainage area for any one check dam or check dam with weir shall be limited to ½ acre.
- C. Dimensions shall be as shown on the Contract Drawings. Check dams shall be constructed of stone or riprap with filter fabric, fiber filtration tubes, or sediment logs, as indicated on the Contract Drawings. Check dams with weirs shall be constructed of stone or riprap with filter fabric. Material specifications for stone, riprap, fiber filtration tubes, and sediment logs appear herein. If Manufacturer's recommendations are more stringent, they shall supersede.
- D. Check dams shall be designed, installed and maintained in accordance with Part 3.0 of this Section. Check dams with weirs shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost of check dams and check dams with weirs shall include all excavation, grading, materials, and all maintenance activities required. Check dams shall be removed from site and the materials disposed of in an approved manner once final stabilization has been achieved.

2.11 INLET EROSION CONTROL MEASURES

- A. Yard, Curb and other Inlet Erosion Control Measures shall be constructed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Inlet erosion control measures shall be used to prevent or limit the introduction of sediment to storm drain systems and allow early use of the of the storm drainage system. Maximum drainage areas for inlet erosion control measures vary from 1 acre for excavated drop inlet protection, hardware & cloth gravel inlet protection, and block and gravel inlet protection to more than 5 acres for rock pipe inlet protection. Other measures may be specified by the Engineer. The materials will be as specified by the Engineer's and Manufacturer's instructions, with more stringent specifications superseding.
- B. Materials for Inlet Erosion Control Measures consist of silt fence, riprap, stone (gravel), hardware wire, sod, concrete blocks, and sediment logs. Riprap and stone for erosion control shall be as specified herein.. Material specifications for sediment logs appear within. If Manufacturer's recommendations are more stringent, they shall supersede.
- C. Inlet Erosion Control Measures shall be designed, installed, and maintained in accordance with Part 3.0 of this Section. Measures shall be designed, installed, and maintained in accordance with the Engineer's and Manufacturer's instructions, with more stringent instructions superseding. The cost of inlet erosion control measures shall include all excavation, grading, materials, and all maintenance activities required. Inlet Control Measures shall be removed from site and the materials disposed of in an approved manner once final stabilization has been achieved.

2.12 FIBER FILTRATION TUBES (FFTS)

- A. FFTs shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.
- B. FFTs shall consist of straw, wood, or coconut fibers, with or without performance-enhancing polymers, encased with cylindrical tubes composed of a heavy-duty, loose-weave, biodegradable natural-fiber netting made of burlap, jute, or coir. The netting shall be oriented in a diamond or hexagonal pattern and shall move freely at all fiber intersections (Leno weave, or equal).
- C. FFTs shall be designed, installed, and maintained as specified herein. If Manufacturer's recommendations are more stringent, they shall supersede. The cost of FFTs shall include all excavation, grading, materials, and all maintenance activities required. FFT's shall be removed from site and the materials disposed of in an approved manner once final stabilization has been achieved.

2.13 TEMPORARY AND PERMANENT CHANNELS

- A. Temporary and permanent channels shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Temporary and permanent channels shall be used to convey concentrated runoff without damage from erosion, deposition or flooding.
- B. Temporary and permanent channels shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost of all temporary and permanent channels shall include all excavation, grading, materials, and all maintenance activities required.

2.14 TEMPORARY SEDIMENT TRAPS, SEDIMENT BASINS, AND SKIMMER SEDIMENT BASINS

- A. Temporary sediment traps shall be constructed as shown on the Contract Drawings, at the termination of all temporary diversions diverting sediment laden runoff, at other locations indicated by the Engineer, and as specified herein. These temporary measures shall not be constructed within an intermittent or perennial stream and shall be installed prior to any land disturbance activities within the drainage area. Temporary sediment traps shall be constructed by excavating the appropriate size rectangular basin and constructing a rock-fill dam on the discharge end. Where specific elevations are not indicated on the Contract Drawings, Contractor shall maintain basins at the depths shown below working grades.
- B. Sediment basins shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Skimmer sediment basins shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. Sediment basins and skimmer sediment basins shall be used where drainage areas are too large for temporary sediment traps. Outlet structures must withdraw from basin surface unless drainage area is less than 1 acre. They shall retain sediment on the site and prevent off site sediment in waterways, and they shall not be located in intermittent or perennial streams. Sediment basins and skimmer sediment basins shall be installed prior to any land disturbance activities within the drainage area.
- C. Porous baffles shall be installed in temporary sediment traps, sediment basins, and skimmer sediment basins as shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.

Porous baffles are used to reduce the velocity and turbulence of the water flowing through the structure and to facilitate the settling of sediment in the water before discharge. They effectively spread the flow across the entire width of a structure.

- D. Material used for porous baffles shall be as indicated on the Contract Drawings. Typical materials include silt fence, coir erosion blanket, coir mesh, and tree protection fence. Other materials may be used as noted on the Contract Drawings and indicated by the Engineer.
- E. The structure life for temporary sediment traps shall be limited to 2 years. Temporary sediment traps shall be spaced to limit the maximum tributary drainage area to 5 acres. The basin life of sediment basins and skimmer sediment basins shall be limited to 3 years unless they are designed as permanent structures. The drainage area for sediment basins and skimmer sediment basins shall be limited to 100 acres.
- F. The principal spillway for sediment basins shall consist of a riser and barrel. Ensure that the pipe is capable of withstanding the maximum expected load without yielding, buckling, or cracking. The basin should be provided with a skimmer or flashboard riser to dewater the basin from the water surface. The emergency spillway shall be constructed in undisturbed soil. The principal spillway outlet and emergency spillway shall be stabilized as shown on the Contract Drawings. Materials shall be as noted on the Contract Drawings.
- G. The principal spillway for skimmer sediment basins shall consist of a skimmer which dewater the basin from the top of the water surface at a controlled rate. A dewatering rate of 24 to 72 hours is required. The skimmer outlet pipe shall be capable of withstanding the maximum expected load without yielding, buckling, or cracking. The emergency spillway shall be constructed in undisturbed soil whenever possible. The principal spillway outlet and emergency spillway shall be stabilized as shown on the Contract Drawings.
- H. Temporary sediment traps shall be designed, constructed and maintained in accordance with Part 3.0 of this Section, to the satisfaction of the Engineer, until the sediment producing areas have been permanently stabilized. The cost of the temporary sediment traps shall include the excavation, grading, fill, baffles, stone for erosion control, washed stone, geotextile, etc. and all maintenance activities required.
- I. Sediment basins shall be designed, installed and maintained in accordance with Part 3.0 of this Section. Skimmer sediment basins shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost of sediment basins and skimmer sediment basins shall include all excavation, grading, materials, and all maintenance activities required.
- J. Porous baffles shall be designed, installed and maintained in accordance with Part 3.0 of this Section. The cost of porous baffles shall include all excavation, grading, materials, and all maintenance activities required.

2.15 OUTLET STABILIZATION STRUCTURE

- A. Outlet stabilization structures shall be constructed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein. These structures shall be used where the discharge velocity of the upstream water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

- B. Structures shall be sized for a capacity equivalent to a 10-year, peak runoff or design discharge of the water conveyance structure, whichever is greater. Riprap materials shall be as specified on the Contract Drawings.
- C. Outlet stabilization structures shall be designed, installed, and maintained in accordance with Part 3.0 of this Section. The cost of outlet stabilization structures shall include all excavation, grading, materials, and all maintenance activities required.

2.16 FLEXIBLE GROWTH MEDIUM (FGM)

- A. FGM shall be applied at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.
- B. FGM is a spray-on flexible blanket that controls soil erosion and accelerates seed germination for establishment of vegetation. It is made of wood fibers, man-made fibers, and additives that are applied wet to the prepared surface. The FGM may be mixed with seed and fertilizer prior to application. Seed and fertilizer rates shall comply with applicable stabilization of disturbed area requirements of this Section.
- C. FGM shall not be used in areas of concentrated flow unless installed in conjunction with a RECM or HPTRM.
- D. FGM shall be installed and maintained in accordance with Part 3.0 of this Section. If Manufacturer's recommendations are more stringent, they shall supersede. The cost of FGM shall include all materials, installation, and all maintenance activities required.

2.17 TREE PROTECTION FENCE

- A. Tree protection fence shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.
- B. Tree protection fence shall be used to protect trees and their root zones during construction. Tree protection fence shall be brightly-colored, UV-resistant poly barricade fabric. Signs designating the area as protected shall be installed on all sides of the fence. Wording and spacing of the signage shall be as indicated on the Contract Drawings.
- C. Tree protection fence shall be installed and maintained in accordance with Part 3.0 of this Section. The cost of tree protection fence shall include all materials as well as all maintenance activities required.

PART 3 – EXECUTION

3.01 INSTALLATION AND MAINTENANCE

- A. All installation and maintenance shall be conducted in accordance with this specification . In the event of a discrepancy between this specification, and Manufacturer's recommendations, the more stringent requirements shall take precedence.

- B. If applicable, all requirements of the NPDES Permit shall be followed. In the event of a discrepancy between this specification and the NPDES Permit requirements, the more stringent requirements shall take precedence.
- C. If possible, erosion and sedimentation control devices shall be established prior to clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established concurrent with the clearing operations or immediately following completion of the clearing operations.
- D. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. At a minimum, maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Of the maintenance requirements specified herein, the more stringent shall take precedence for each and every sediment and erosion control measure utilized on the site. Maintenance shall include but not be limited to 1) the removal and satisfactory, legal disposal of accumulated sediment from traps or silt barriers and 2) replacement of filter fabrics used for silt fences and stone impaired by sediment in stone filters, gravel construction entrances, etc. Maintenance as noted in items 1) and 2) above shall be performed as required, and at least once every 3 months for the duration of construction activities. Sediment removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in off-site sedimentation as acceptable to the Engineer, at no additional cost to the Owner. If no suitable on-site locations are available, all such sediment will be legally disposed of off site, at no additional cost to the Owner.

3.02 SILT FENCE

- A. Silt fence shall be erected at the locations shown on the Contract Drawings and at all other locations as may be directed by the Engineer. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Replacement of the filter fabric and its associated appurtenances, if required by the Engineer, will be at the Contractor's expense.
- B. Silt fence shall not be installed across streams, ditches, waterways or other areas of concentrated flow. Silt fence shall be placed at least 6 feet beyond the toe of slope of any embankment or stockpile area to allow space for ponding and maintenance access.
- C. Dig a trench approximately 8 inches deep and 4 inches wide and place the fabric in the bottom of the excavated ditch or use the slicing method to insert the fabric into a cut sliced in the ground with a disc. Ensure that the height of the sediment fence does not exceed 24 inches above the ground surface.
- D. Install posts 4 feet apart in critical areas and 6 feet apart on standard applications when extra strength filter fabric is used. When wire mesh support is used, posts shall be installed a maximum of 8 feet apart. Install posts 2 feet deep on the downstream side of the silt fence, as close as possible to the fabric.
- E. Joints should be avoided along the fencing. When joints are necessary, securely fasten the filter cloth only at a support post with 4 feet minimum overlap to the next post.

- F. Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of 4 trips.
- G. Stabilized outlets for silt fence shall be provided at locations shown on the Contract Drawings. The outlet section shall have a maximum width of 4 feet. The height of silt fence at the outlet shall be a maximum of 1 foot. A 5 foot x 5 foot (minimum) apron of #57 washed stone shall be provided on the downstream side of the silt fence outlet.
- H. Silt fence shall be erected around all catch basins which are located downstream from any construction work unless other inlet protection is specified. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins. Upon completion of the modification, the area shall be rough graded, as shown on the Contract Drawings, until the end of the project, at which time final grading shall occur.
- I. Inspect silt fence at least once a week and after each rainfall event. Make any required repairs immediately.
- J. Should the fabric of any silt fence collapse, tear, decompose or become ineffective, replace it promptly. All fabric shall be replaced after the first 6 months of construction activity and every 6 months thereafter until construction activities are complete, unless otherwise directed by the Engineer.
- K. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.
- L. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized. Removal of any silt fence shall be permitted only with the prior approval of the Engineer or the local governing agency.

3.03 STONE FOR EROSION CONTROL

- A. Stone for erosion control shall be designed, installed, and maintained in accordance with the requirements of Section 6.15 of the ESCPDM. Stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above, to protect structures from damage when rock material is placed against the structures, or to protect the underlying Separator Geotextile from damage during installation.
- B. Inspect at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Remove accumulated sediment and replace stone impaired by sediment as necessary.

3.04 RIPRAP

- A. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone. The placed riprap shall

have a minimum depth of 24 inches unless otherwise specified by the Engineer. Inspect periodically for scour or dislodged stones. Control of weed and brush growth may be needed.

3.05 ROLLED EROSION CONTROL MATTING (RECM)

- A. The Engineer may direct the Contractor to place RECMs in permanent channels or on slopes at other locations in addition to those shown on the Contract Drawings. If Manufacturer's instructions are more stringent, they shall supersede.
- B. The Contractor shall place the RECMs where directed immediately after the channel or slope has been properly graded and, if applicable, prepared, fertilized, and seeded.
- C. Grade the surface of the installation area so that the ground is smooth and loose. Remove all large rocks, debris, etc. so as to ensure that good contact between the RECM and the ground is maintained so that no erosion occurs beneath the RECM. Terminal anchor trenches are required at RECM ends and intermittent trenches must be constructed across channels at 25-foot intervals. Terminal anchor trenches should be a minimum of 12 inches in depth and 6 inches in width, while intermittent trenches should be a minimum of 6 inches deep and 6 inches wide. Take care to maintain direct contact between the soil and the RECM.
- D. For slope installation, place RECM 2-3 feet over top of slope and into an approximately 12 inch deep by 6 inch wide excavated end trench. Using staples, stakes, or pins, anchor the RECM at 1 foot intervals along the bottom of the trench, backfill, and compact. Along the slope, pin the RECM in a 3 foot center-to-center pattern; provide a minimum 3 inch overlap for adjacent rolls.
- E. For channel installations, excavate 12 inch deep by 6 inch wide terminal trenches across the upper and lower end of the lined channel. Anchor the RECM at a minimum of 25 foot intervals utilizing either two rows of anchors or 6 inch by 6 inch cross trenches. Bury outside RECM edges in longitudinal trenches 6 inches deep and wide along the channel edges. Pin the RECM in at 1 foot intervals along the bottom of terminal trenches, backfill, and compact. Overlap adjacent rolls a minimum of 3 inches and pin at 1 foot intervals. Place the first RECM at the downstream end of the channel and unroll upstream. When starting installation of a new roll, begin in a trench or shingle-lap ends of rolls a minimum of 1 foot with upstream RECM on top to prevent uplifting.
- F. Staples, stakes, and pins shall be driven so that the top is flush with the ground.
- G. During the establishment period, check RECMs at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Immediately make repairs. Good contact with the ground must be maintained. Monitor and repair the RECM as necessary until ground cover is established.

3.06 TEMPORARY AND PERMANENT DIVERSIONS

- A. The Contractor shall provide temporary and permanent diversions at all locations noted on the Contract Drawings and at all other locations as may be directed by the Engineer.
- B. Remove and properly dispose of all trees, debris, etc. Fill and compact all ditches, swales, etc. that will be crossed to natural ground level or above.

- C. Excavate, shape and stabilize diversions as shown on the Contract Drawings and described herein. Unless otherwise noted, provide vegetative stabilization immediately after installation of permanent diversions. Temporary diversions that are to serve longer than 7 working days shall be seeded and mulched as soon as they are constructed to preserve dike height and reduce maintenance. Seed and mulch disturbed areas draining into the diversions within 14 calendar days of completing any phase of grading.
- D. For temporary diversions, ensure that the top of the dike is not lower at any point than the design elevation plus the specified settlement. Provide sufficient room around temporary diversions to permit machine re-grading and cleanout. Vegetate the ridge of temporary diversions immediately after construction unless they will remain in place less than 7 working days.
- E. Provide outlet protection adequate to accept flow from diversion plus any other contributing runoff. Sediment-laden runoff shall be routed through a sediment-trapping device.
- F. Inspect temporary diversions once a week and after every rainfall event. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it. Inspect permanent diversions weekly and after every rainfall event during construction operations until permanent vegetation is established. After vegetation is established, inspect after major storms. Immediately remove any debris and make repairs as needed in a timely manner. Maintain healthy vegetation at all times.

3.07 TEMPORARY SLOPE DRAINS

- A. The Contractor shall provide temporary slope drains with inlet and outlet protection and associated diversion channels at all locations noted on the Contract Drawings, and at other locations as may be directed by the Engineer.
- B. Place slope drains on undisturbed soil or well compacted fill. Slightly slope the section of pipe under the dike toward its outlet. Hand-tamp the soil under and around the entrance section in lifts not to exceed 6 inches.
- C. Ensure that all slope drain connections are watertight. Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 feet apart. Extend the drain beyond the toe of the slope and provide outlet protection.
- D. Immediately stabilize all disturbed areas following construction.
- E. Inspect the temporary slope drain, inlet and outlet protection, and supporting diversions weekly and after every rainfall event and promptly make any necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.

3.08 TEMPORARY GRAVEL CONSTRUCTION ENTRANCES/EXITS

- A. The Contractor shall provide temporary gravel construction entrances/exits at all locations noted on the Contract Drawings and at all other locations as may be directed by the Engineer.

- B. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2 – 3 inch stone. Inspect each construction entrance at least weekly and after each rainfall event and replace stone impaired by sediment as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.
- C. If, despite the use of a gravel construction entrance/exit, most of the mud and sediment are not removed from vehicle tires, tire washing may be necessary as detailed in Section 6.06 of the NC ESCPDM. If necessary, this shall be done at no additional cost to the Owner.

3.09 TEMPORARY AND PERMANENT STABILIZATION OF DISTURBED AREAS

- A. The Contractor shall temporarily stabilize disturbed areas that will not be brought to final grade within 14 calendar days unless as noted in Paragraph 1.01 E of this Section. Temporary seeding shall be applied on areas that include diversions, dams, temporary sediment basins, temporary road banks and topsoil stockpiles. Areas to be stabilized with permanent vegetation must be seeded or planted within 14 working days after final grade is reached, unless temporary stabilization is applied. Temporary seeding provides protection for no more than 1 year, after which permanent stabilization should be initiated.
- B. Complete grading before preparing seedbeds and install all necessary erosion control measures. Minimize steep slopes. If soils become compacted during grading, loosen to a depth of 6-8 inches.
- C. Reseed and mulch temporary seeding areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.
- D. The operation of equipment is restricted on slopes steeper than 3:1. Provisions for vegetation establishment can be made during final grading. Vegetation chosen for these sites must not require mowing or other intensive maintenance. Good mulching practices are critical for protecting against erosion on steep slopes.
- E. Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect seeded areas for failure and make necessary repairs and reseedings within the same season, if possible.
- F. Reseeding – If a stand has inadequate cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary, annual species if the time of year is not appropriate for permanent seeding.
- G. If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.
- H. Fertilization - On the typical disturbed site, full establishment usually requires re-fertilization in the second growing season. Fine turf requires annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixture.
- I. Inspect all seeded areas weekly and after heavy rains until permanent cover is established. Inspect within 6 weeks of planting to see if stands are adequate. Fertilize, reseed and mulch damaged and sparse areas immediately.

3.10 CHECK DAMS AND CHECK DAMS WITH WEIRS

- A. The Contractor shall provide check dams or check dams with weirs at all locations noted on the Contract Drawings and at all other locations as may be directed by the Engineer.
- B. Stone shall be placed on a filter fabric foundation. Center stone shall be at least 9 inches below natural ground level and stone shall extend 1.5 feet beyond ditch bank.
- C. For check dams with weirs, provide an apron with a length 3 times the height of the dam and a width a minimum of 4 feet. A 12-inch layer (minimum) of sediment control stone shall be placed on the upstream side of the dam. Excavate sediment storage area to the dimensions shown on the Contract Drawings.
- D. Fiber filtration tubes and sediment logs may be specified for use as check dams. These measures shall be installed according to instructions included herein. If Manufacturer's recommendations are more stringent, they shall supersede.
- E. Spacing shall be such that the elevation of the top of the lower dam is the same as the toe elevation of the upper dam.
- F. Check dams and check dams with weirs shall be inspected at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Sediment, limbs and other debris shall be cleared from the channel. Repairs shall be made immediately.

3.11 INLET EROSION CONTROL MEASURES

- A. Engineer's and Manufacturer's instructions for design, installation, and maintenance shall be followed, with more stringent instructions superseding. The Contractor shall provide inlet erosion control measures at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.
- B. Drainage area is limited to 1 acre. The minimum volume of excavated area around the drop inlet is 1800 ft³/acre disturbed. Minimum depth of the excavated area shall be 1 foot and maximum depth shall be 2 feet as measured from the crest of the inlet structure. Weep holes shall be protected by gravel. Inspect the excavated basin at least weekly and after every storm event until the contributing drainage area has been permanently stabilized. Remove sediment when the storage volume has been reduced by one-half.
- C. Drainage area shall be limited to 1 acre unless site conditions allow for frequent removal of accumulated sediment. The height of the block barrier shall be no more than 12 inches and no less than 24 inches. On the bottom row, place some of the blocks on their side to allow for dewatering. Place wire mesh over all block openings to hold gravel in place. Lateral support may be provided by placement of 2 x 4 wood studs through block openings. Place gravel 2 inches below the top of the block barrier. The top elevation of the structure must be at least 6 inches below the ground elevation downslope from the inlet to ensure that all stormwater flows over the structure and enters the storm drain instead of bypassing the structure. Block and gravel inlet protection shall not be used near the edge of fill material and shall not divert water away from the storm drain. Inspect at least weekly and after every storm event until the contributing drainage area has been permanently stabilized. Remove sediment as necessary to provide adequate storage volume for subsequent rains. Replace stone as needed.

- D. Rock pipe inlet protection may be used at pipes with a maximum diameter of 36 inches. It shall not be installed in intermittent or perennial streams. The minimum crest width of the riprap berm shall be 3 feet, with a minimum bottom width of 11 feet and minimum height of 2 feet. The top of the riprap shall be 1 foot lower than the shoulder of the embankment or diversions. The outside face of the riprap should be covered with a 12-inch thick layer of #5 or #57 washed stone. The sediment storage area should be excavated upstream of the rock pipe inlet protection, with a minimum depth of 18 inches below grade. The rock pipe inlet protection shall be inspected at least weekly and after any storm event of greater than 1 inch of rain per 24-hour period. Repairs shall be made immediately. Remove sediment when the volume of the sediment storage area has been decreased by one-half and replace the contaminated part of the gravel facing.

3.12 FIBER FILTRATION TUBES (FFTS) AND SEDIMENT LOGS

- A. FFTs and sediment logs shall be placed along slopes to function as slope breaks and to minimize sediment transport and in diversions/channels to serve as check dams. The Contractor shall provide FFTs and sediment logs at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.
- B. FFTs and sediment logs shall be installed to maintain contact with the soil surface. Install prior to seeding. May be installed before or after installation of RECMs.
- C. Anchor the upstream/upslope side of the FFTs using wire staples or approved devices at 1-foot intervals. Drive wooden stakes through downstream/downslope side of the FFTs at 2-foot intervals. Take care not to compress the FFTs. Backfill and compact loose soil against the upstream/upslope side. Overlap adjacent FFT ends by a minimum of 1 foot.
- D. For channel installation, construct anchor trench 3 inches deep by FFT diameter and place loose soil against upstream side of FFT. For channel gradients of 2%, install trenches on 25-foot intervals. Decrease interval distance with steeper channel gradients or more highly erosive soils.
- E. Any sediment accumulation at the base of the FFT must be removed when it reaches one-third of the height of the tube. FFT may need to be removed if fully loaded with captured sediment for maximum product performance. FFTs are to be left in place or removed from the site as directed by the Engineer.
- F. Sediment logs do not require installation trenches. Wood stakes shall be placed at least every 2 feet along the length of the sediment log. Stakes shall only penetrate the netting around the log. They shall not be driven through the center of the log. Sediment logs are to be left in place or removed from the site as directed by the Engineer.
- G. The FFTs and sediment logs shall be inspected at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Look for signs of flow undercutting the logs. Re-anchor and replace as necessary.

3.13 TEMPORARY AND PERMANENT CHANNELS

- A. The Contractor shall provide temporary and/or permanent channels at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.

- B. Remove all trees, brush, stumps, etc. from the channel area and dispose of properly.
- C. Excavate the channel to the dimensions shown on the plans, over-excavating to allow for liner thickness. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.
- D. Armor the channel as specified on the Contract Drawings. If the specified channel lining requires an establishment period, protect the channel with mulch or a temporary liner sufficient to withstand anticipated velocities during this period.
- E. During the establishment period, inspect channels weekly and after every rainfall. After lining has been fully established, inspect channels after any storm event of greater than 1 inch of rain per 24-hour period. Immediately make repairs.
- F. Perform all channel construction to keep erosion and water pollution to a minimum. Immediately upon completion of the channel, vegetate all disturbed areas or otherwise protect them against soil erosion. Where channel construction will take longer than 7 days, stabilize channels by reaches.
- G. Inspect the channel outlet and all road crossings for bank stability and evidence of piping or scour holes. Give special attention to outlets and points where concentrated flow enters the channel.
- H. Maintain all vegetation adjacent to and in the channel in a healthy, vigorous condition to protect the area from erosion.
- I. Remove all significant sediment accumulations to maintain the designed carrying capacity.

3.14 TEMPORARY SEDIMENT TRAPS, SEDIMENT BASINS, AND SKIMMER SEDIMENT BASINS

- A. The Contractor shall provide these structures at all locations shown on the Contract Drawings and at all other locations as may be directed by the Engineer.
- B. Care shall be taken to ensure that proper site preparation operations are conducted prior to trap or basin construction. Clear, grub and strip embankment location.
- C. A cut-off trench shall be excavated along the center line of the earth fill embankment for sediment basins and skimmer sediment basins. Keep the trench dry during backfilling and compaction operations.
- D. Fill material shall be free of roots, woody vegetation, rocks, and other objectionable materials. Fill shall be placed in 6 to 8-inch layers and compacted. Construct the embankment to an elevation 10 percent (minimum of 6 inches) higher than the design height to allow for settling.
- E. Inlets to the sediment traps and basins shall be constructed so as to prevent erosion. Use diversions to divert sediment-laden water to the upper end of the basin.
- F. Shape the sediment trap or basin to the specified dimensions.
- G. Following construction of the embankment, clear the sediment trap or basin area below the crest elevation of the spillway to facilitate sediment cleanout. Provide access for cleanout of accumulated sediment.

H. Spillway/outlet configuration shall be constructed as specified below.

I. Temporary sediment trap

1. Construct riprap outlet in embankment. Use filter fabric or a keyway cutoff trench between the riprap and the soil to protect it from piping. The outlet weir must be level and constructed to grade to assure design capacity. Ensure that the stone spillway outlet extends downstream past the toe of the embankment until the outlet velocity is acceptable for the receiving stream.
2. Provide emergency bypass in natural, stable areas, located so that flow will not damage the embankment.

J. Sediment basin

1. Securely attach the riser to the barrel or barrel stub to make a watertight structural connection. Secure all barrel connections with approved watertight assemblies. Install anti-seep collar(s) as noted on the Contract Drawings. Ensure that the pipe stays in firm contact with its foundation when compacting fill around the pipe. Do not use pervious material as backfill around the pipe. Anchor the riser to prevent floatation. Install trash guard to prevent the riser and barrel from becoming clogged.
2. Install basin dewatering mechanism as noted on the Contract Drawings.
3. Install outlet protection as specified at principal spillway outlet. Install the emergency spillway in undisturbed soil and provide stabilization as specified.

K. Skimmer sediment basin

1. Excavate a shallow pit under the skimmer or provide a low support of stone or timber under the skimmer to prevent the skimming device from settling into the mud.
2. Place the barrel on a firm, smooth foundation of impervious soil. Do not use pervious material to backfill around the pipe. Ensure that the barrel stays in firm contact with its foundation when compacting fill around the pipe.
3. Assemble the skimmer following the Manufacturer's instructions, or as designed.
4. Lay the assembled skimmer on the bottom of the basin with the flexible joint at the inlet of the barrel pipe. Attach the flexible joint to the barrel pipe and position the skimmer over the excavated pit or support. Attach a rope to the skimmer and anchor it to the side of the basin so that the skimmer may be pulled to the side for maintenance.
5. Install the spillway in undisturbed soil to the greatest extent possible and line with laminated plastic or impermeable geotextile fabric. Anchor the edges of the fabric in a trench with staples or pins. Install outlet protection as specified at the principal spillway outlet.

- L. Install porous baffles in temporary sediment traps, sediment basins, and skimmer sediment basins as shown on the Contract Drawings and as specified herein. The Contractor shall provide porous baffles at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.
 - 1. Care shall be taken when installing porous baffles so they perform as designed. Baffle material shall be secured at the bottom and sides of sediment trap or basin. Fabric shall not be spliced but a continuous piece shall be used across the trap or basin.
 - 2. Install at least three rows of baffles between the inlet and outlet discharge point. Sediment traps and basins less than 20 feet in length may use 2 baffles.
 - 3. Posts or sawhorses shall be installed across the width of the sediment trap or basin unless an alternate baffle configuration is shown on the Contract Drawings. Steel posts shall be driven to a depth of 24 inches, spaced a maximum of 4 feet apart. Baffle weirs shall be installed at locations and according to details on the Contract Drawings. Except in locations of baffle weirs, the top of the fabric shall be 6 inches higher than the invert of the spillway and 2 inches lower than the top of the berms.
- M. Sediment traps and basins shall be constructed so that the area disturbed and resulting erosion is minimized. The emergency spillway, embankment, and all other disturbed areas above the crest of the principal spillway are to be stabilized immediately after construction.
- N. Sediment traps and basins may attract children and should be considered dangerous. Steep side slopes should be avoided and fences with warning signs may be necessary if trespassing is likely.
- O. Inspect temporary sediment traps, sediment basins, and skimmer sediment basins once a week and within 24 hours after any storm event of greater than ½ inch of rain per 24-hour period. Repairs shall be made immediately.
 - 1. Sediment, limbs and other debris shall be cleared and the trap or basin shall be restored to its original dimensions when it accumulates to one-half the design depth or more frequently as directed by the Engineer. Sediment material removed from traps and basins shall be disposed of by the Contractor in locations that will not result in off-site sedimentation as acceptable to the Engineer, at no additional cost to the Owner. If no suitable on-site locations are available, all such sediment will be legally disposed of off site, at no additional cost to the Owner.
 - 2. The embankment, spillways and outlet shall be checked for erosion damage and the embankment shall be checked for piping and settlement. Immediately fill any settlement of the embankment to slightly above design grade. Any riprap displaced from the spillway must be replaced immediately. Replace contaminated gravel facing of riprap outlets as necessary. Inspect vegetation. Reseed and re-mulch as necessary.
 - 3. Baffles, fabric and skimmer shall be inspected for damage. Repairs shall be made immediately. Re-anchor baffles if water is flowing under or around them.
 - 4. Debris shall be removed from the skimmer to prevent clogging. Special precautions shall be taken in winter to prevent the skimmer from plugging with ice.

3.15 OUTLET STABILIZATION STRUCTURE

- A. The Contractor shall ensure the subgrade, riprap and gravel filter conforms to the grading limits shown on the plans.
- B. Riprap shall be installed in accordance with the specifications contained herein, with filter fabric placed under the riprap.
- C. The apron shall be constructed on zero grade with no overfill. Ensure the apron is properly aligned with the receiving stream.
- D. All disturbed areas shall be stabilized with vegetation immediately after construction.
- E. Outlet stabilization structures shall be inspected at least weekly and within 24 hours after any storm event of greater than ½ inch of rain per 24-hour period to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Repairs shall be made immediately.

3.16 FLEXIBLE GROWTH MEDIUM

- A. Flexible growth medium shall be applied and maintained in accordance with the requirements detailed herein. If Manufacturer's recommendations are more stringent, they shall supersede.
- B. Grade area according to the Contract Drawings and prepare seedbed in accordance with this Section and Section 32 90 00 – Final Grading and Landscaping.
- C. Apply flexible growth medium at rate noted on the Contract Drawings. Application may be made either in conjunction with application of seed and fertilizer or following application of seed and fertilizer. Slope interruption devices are recommended when slope lengths exceed 100 feet. Traffic shall be kept off treated areas.
- D. Areas treated with flexible growth medium shall be inspected at least weekly and within 24 hours after any storm event of greater than ½ inch of rain per 24-hour period until vegetation is established. Reapply in areas where seedling emergence is poor.

3.17 TREE PROTECTION FENCE

- A. If Manufacturer's recommendations are more stringent, they shall supersede.
- B. Install tree protection fence around all designated tree protection areas prior to clearing, deliveries, and other construction activities onsite. Post signs designating area as protected on all sides of the fencing.
- C. Inspect tree protection fence weekly. Repair and replace as needed.

3.18 ADDITIONAL REQUIREMENTS

- A. All storm sewer piping shall be blocked at the end of every working day until the inlet is constructed above grade.

- B. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.
- C. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains, curb inlets (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of offsite areas. Silt fence will be provided, at no additional cost to the Owner, around excavation materials if deemed necessary by the Engineer. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.
- D. The Engineer may direct the Contractor to place any additional sediment and erosion control devices at other locations not shown on the Drawings.

3.19 INSPECTIONS AND MAINTENANCE

- A. The Contractor shall designate an Authorized Representative to perform inspections and maintenance as described herein. Contractor shall perform regular inspections and maintain records as follows:
 - 1. Inspections shall be performed, at a minimum, once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period.
 - 2. A rain gauge shall be maintained in good working order on the site and all rainfall amounts recorded throughout the duration of construction activities.
 - 3. Inspection reports must be available on-site during business hours unless a site-specific exemption is approved.
 - 4. Inspection records must be kept for 3 years following completion of construction and be available upon request.
 - 5. Electronically-available records may be substituted under certain conditions as approved by Land Quality and DWQ.
- B. During inspections, the following will be observed and appropriate maintenance activities shall be performed:
 - 1. The conformance to specifications and current condition of all erosion and sediment control structures.
 - 2. The effectiveness and operational success of all erosion and sediment control measures.
 - 3. The presence of sediments or other pollutants in storm water runoff at all runoff discharge points.
 - 4. The presence of sediments or other pollutants in receiving waters.
 - 5. Evidence of off-site tracking at all locations where vehicles enter or exit the site.

6. Evidence of impacts to water quality due to site activities pertaining to equipment operation and maintenance, material handling, and material storage and construction laydown areas exposed to precipitation.
- C. Immediate action shall be taken to repair/maintain erosion and sediment control measures that are not performing as designed. The State/Commonwealth reserves the right to stop all construction activities not related to these measures until such deficiencies are repaired.
 - D. In areas that have undergone final stabilization, inspections and, if necessary, maintenance by Contractor will occur at least once per month for the duration of the contract or project, whichever is longer.

3.20 MONITORING AND REPORTING

- A. Monitoring: The Contractor shall be responsible for the implementation of the Inspections and Maintenance Procedures as included in the approved erosion and sediment control plan. The implementation must comply with any local regulatory authorities. Minimum monitoring requirements are as follows:
 1. A rain gauge shall be maintained in good working order on the site.
 2. A written record of the daily rainfall amounts shall be retained. (Note: if no rainfall occurred the Contractor must record "zero").
 3. The control measures shall be inspected to ensure that they are operating correctly. Inspection records must be maintained for each inspection event and for each measure. All erosion and sedimentation control measures must be inspected by the Contractor at least once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period unless otherwise noted herein. Some measures require inspection following each rainfall event.
 4. Once land disturbance has begun on the site, stormwater runoff discharge outfalls shall be inspected by observation for erosion, sedimentation and other stormwater discharge characteristics such as clarity, floating solids, and oil sheens. Inspections of the outfalls shall be made at least once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Inspection records must be maintained for each inspection event and for each discharge location.
 5. If any visible sedimentation is leaving the site or entering waters of the State/Commonwealth, corrective action shall be taken immediately to control the discharge of sediments. Where visible deposition of sediment has occurred in surface waters or wetlands, the Contractor must verbally contact the Engineer and the Division of Water Quality within 24 hours of becoming aware of the deposition. Written notification shall be made to the Engineer and the Division of Water Quality within 5 days of becoming aware of the deposition.
- B. Reporting: The Contractor must keep a record of inspections onsite with a copy of the approved erosion and sediment control plan. Inspection records shall be made available to DWQ or its authorized agent upon request. Copies of inspection records shall be sent to the Engineer on a monthly basis. The records must provide the details of each inspection including observations and corrective actions taken as described below.

The required rainfall and monitoring observations shall be recorded on a form provided by DEQ or a similar inspection form that is inclusive of all of the elements contained in the Division's form. A sample inspection form can be found at the end of this Section.

1. Control Measure Inspections: Inspection records must include at a minimum: 1) identification of the measures inspected, 2) date and time of the inspection, 3) name of the person performing the inspection, 4) indication of whether the measures were operating properly, 5) description of maintenance needs for the measure, 6) corrective actions taken and 7) date of actions taken.
 2. Stormwater Discharge Inspections: Inspection records must include at a minimum: 1) identification of the discharge outfall inspected, 2) date and time of the inspection, 3) name of the person performing the inspection, 4) evidence of indicators of stormwater pollution such as oil sheen, floating or suspended solids or discoloration, 5) indication of visible sediment leaving the site, 6) actions taken to correct/prevent sedimentation and 7) date of actions taken.
 3. Visible Sedimentation Found Outside the Site Limits: Inspection records must include 1) an explanation as to the actions taken to control future releases, 2) actions taken to clean up or stabilize the sediment that has left the site limits and 3) the date of actions taken.
 4. Visible Sedimentation Found in Streams or Wetlands: All inspections should include evaluation of streams or wetlands onsite or offsite (where accessible) to determine if visible sedimentation has occurred.
 5. Visible Stream Turbidity: If the discharge from a site results in visible stream turbidity, inspection records must record that evidence and actions taken to reduce sediment contributions.
- C. The State/Commonwealth reserves the right to use its own resources to duplicate monitoring and verify the work required by the Contractor in this Section.
1. The Sedimentation Pollution Control Act requires persons responsible for land-disturbing activities to inspect a project after each phase of the project to make sure that the approved erosion and sedimentation control plan is being followed.
 2. The self-inspection program is separate from the weekly self-monitoring program of the NPDES Stormwater Permit for Construction Activities. The focus of the self-inspection report is the installation and maintenance of erosion and sedimentation control measures according to the approved plan. The inspections should be conducted after each phase of the project and continued until permanent ground cover is established.
 3. The Self-Inspection Report form may be found at the end of this Section and is also available as an Excel spreadsheet from the NC DEMLR Land Quality Section web site, http://www.dlr.enr.state.nc.us/pages/sedimentation_new.html
- D. Sites discharging to streams named on the state's 303(d) list as impaired for sediment-related causes may be required to perform additional monitoring, inspections or application of more stringent management practices if it is determined that the additional requirements are needed to assure compliance with the federal or

state/commonwealth impaired-waters conditions. Inspection records must be maintained for each inspection event and for each discharge location. If a discharge covered by this permit enters a stream segment that is listed on the Impaired Stream List for sediment-related causes, and a Total Maximum Daily Load (TMDL) has been prepared for those pollutants, the Permittee must implement measures to ensure that the discharge of pollutants from the site is consistent with the assumptions and meets the requirements of the approved TMDL.

3.21 REMOVAL OF TEMPORARY SEDIMENT CONTROL STRUCTURES

- A. At such time that temporary erosion and sediment control structures are no longer required under this item, the Contractor shall notify the Engineer of its intent and schedule for the removal of the temporary structures. The Contractor shall obtain the Engineer's approval in writing prior to removal. Once the Contractor has received such written approval from the Engineer, the Contractor shall remove, as approved, the temporary structures and all sediments accumulated at the removed structure shall be returned upgrade and stabilized so they do not re-erode. In areas where temporary control structures are removed, the site shall be left in a condition that will restore original drainage. Such areas shall be evenly graded and seeded as specified in Section 32 90 00 – Final Grading and Landscaping.

END OF SECTION

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SECTION 32 10 00
PAVING AND SURFACING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, equipment and materials and perform all operations in connection with the construction of asphalt concrete pavement, asphalt concrete overlay, reinforced concrete pavement, gravel roads, concrete curb and gutter, repair and reconstruction of existing asphalt concrete pavement, repair of existing gravel roads, and pavement markings complete as specified herein and as detailed on the Drawings.
- B. All new roads including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses and types as shown on the Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt and/or gravel, depending upon the material encountered, unless otherwise indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Requirements of related work are included in Division 01 02 and Division 03 of these Specifications.

1.03 RELATED SECTIONS

- A. Section 31 00 01 – Earthwork
- B. Section 03 30 00 – Cast-in-Place Concrete

1.04 REFERENCES

- A. Utah Department of Transportation Standard Specifications and Standard Drawings.

PART 2 – MATERIALS

2.01 SELECT FILL

- A. The Contractor shall place select fill as necessary to complete the embankments, shoulders, subgrade foundation and replacement for removed unsuitable material in accordance with Section 31 00 01 – Earthwork.

2.02 GRAVEL

- A. All work, including materials, associated with gravel shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.

2.03 AGGREGATE STABILIZATION

- A. All work, including materials, associated with Aggregate Stabilization shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.

2.04 AGGREGATE BASE COURSE (ABC)

- A. All work, including materials, associated with Aggregate Base Course shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.

2.05 ASPHALT BINDER FOR PLANT MIX

- A. All work, including materials, associated with asphalt binder shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.

2.06 ASPHALT PAVEMENTS

- A. All work, including materials, associated with asphalt pavement shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.
- B. The job mix formulas shall be delivered to the Engineer at least two (2) weeks prior to beginning paving operations.

2.07 RIGID PORTLAND CEMENT CONCRETE PAVEMENT

- A. All work, including materials associated with rigid concrete pavement shall be in accordance with Section 03 30 00 – Cast-in-Place Concrete. Class A concrete shall be used. Placement shall be in accordance with Section 03 30 00 – Cast-in-Place Concrete.

2.08 RIGID CONCRETE PAVEMENT REINFORCING

- A. Reinforcing, if specified, shall be as shown on the Structural Drawings and as specified under Section 03 21 00 – Reinforcing Steel.

2.09 CONCRETE CURB AND GUTTERS

- A. Concrete shall be Class B in accordance with the requirements of Section 03 30 00 – Cast-in-Place Concrete, except that concrete shall be air-entrained to provide an air content of $6\% \pm 1.5\%$.
- B. Premolded expansion joint filler for expansion joints shall conform to ASTM D 1751 and shall be 1/2-inch thick, minimum.

2.10 ASPHALT TACK COAT

- A. All work, including materials, associated with asphalt tack coat shall be in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.

2.11 POLYCYCLIC AROMATIC HYDROCARBON (PAH)

- A. The EPA has classified seven PAHs as probable human carcinogens, and 16 PAHs as Priority Pollutants. Materials containing concentrations of Polycyclic aromatic hydrocarbon (PAH), such as Coal Tar Based Sealcoat, higher than allowed by OSHA limits shall not be allowed for use on the project.

PART 3 – EXECUTION

3.01 EMBANKMENT

- A. The embankment shall be constructed in accordance with Section 31 00 01 – Earthwork.

3.02 SUBGRADE

- A. The subgrade, where shown on the Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3 inches of subgrade. Aggregate stabilization shall be applied to the subgrade at a rate of 300 pounds per square yard. Following the application of stabilizer aggregate, the subgrade shall be formed true to crown and grade and shall be compacted with a minimum of four (4) passes of a 15 ton vibratory roller to conform to the maximum densities determined by AASHTO T99 Standard Specifications.

3.03 BASE COURSE

- A. The finished base course of all paving shall be ABC and shall be of the thickness shown on the Drawings, formed true to crown and grade. Gravel roads, including repair to existing gravel roads shall be ABC and shall be of the thicknesses shown on the Drawings, formed true to crown and grade. No fill material except new ABC shall be placed on top of existing gravel.

3.04 ASPHALT BASE COURSE (OR INTERMEDIATE COURSE)

- A. Asphalt Concrete Base (or Intermediate) Course shall meet the requirements of Superpave BM-25.0C (IM-19C for Intermediate) and be placed in lifts with a minimum thickness of 3-inches (2.5-inches for Intermediate) and a maximum thickness of 4-inches for IM-19C in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings. Thicknesses shall be as shown on the Drawings.

3.05 ASPHALT CONCRETE SURFACE COURSE

- A. Prior to placement of the asphalt concrete surface course, the base/intermediate course shall be inspected for damage or defects and repaired to the satisfaction of the Engineer. The surface of the base/intermediate course shall be approved by the Engineer.
- B. Equipment for applying the tack coat shall be power oriented pressure spraying or distributing equipment suitable for the materials to be applied and approved by the Engineer.
- C. The Asphalt Concrete Surface Course shall meet the requirements of Superpave SM-9.5B and be placed and compacted on the base/intermediate course in layers with a minimum thickness of 1-1/2 inches and a maximum thickness of 3-inches and at the rate of 110 pounds per square yard per inch. Surface Course shall be compacted in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings. Thicknesses shall be as shown on the Drawings.

3.06 ASPHALT CONCRETE PAVEMENT COMPACTION

- A. Asphalt concrete pavement compaction shall be performed as per Utah Department of Transportation Standard Specifications and Standard Drawings.
- B. Contractor shall provide Quality Control (QC) for proper asphalt concrete pavement placement and compaction using equipment in good working order which has been properly calibrated at the start of each round of testing. Quality Assurance (QA) of paving operations will be performed by an independent third-party representative hired by Owner.
- C. Immediately after the asphalt mixture has been spread, struck off and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix

to the required degree of compaction for the type of mixture being placed.

3.07 ASPHALT CONCRETE DENSITY ACCEPTANCE

- A. The Engineer will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's QC test results, the Owner's QA test results (including verification samples) and by observation of the Contractor's density QC process conducted in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings.
- B. Minimum density requirements for all mixes will be as specified in Table 3-1. Density acceptance will be as provided herein. Core sample shall be obtained and tested by the Owner's representative at the same frequency and location as the Contractor's QC testing, if possible, and densities will be determined by use of the requirements as outlined in Utah Department of Transportation Standard Specifications and Standard Drawings.
- C. A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. A lot will consist of one day's production of a given JMF, for each layer of asphalt concrete placed. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average.
- D. Any lot or portion of a lot deemed obviously unacceptable by the Owner or Engineer will be rejected for use in the work. If the Engineer determines that a given lot of mix does not meet the minimum specification requirements, but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the contractor's schedule of values.
Reduced Pay Factor = $100 + \frac{(\text{Actual Density} - \text{Specified Density}) \times 30}{2}$

2

Where: Actual Density = the lot average density, not to exceed 2.0% of the specified density

Specified Density = the density as specified in the contract

3.08 ASPHALT CONCRETE PAVEMENT PHASING

- A. Contractor shall be responsible for phasing the placement of asphalt concrete pavement sections and courses to account for individual construction activities, the construction traffic volume, and vehicle loading expected throughout construction activities. The placement of asphalt concrete pavement shall also be phased so the aggregate base course, once installed, is not exposed to freeze/thaw cycles.

3.09 RIGID PORTLAND CEMENT CONCRETE

- A. The subgrade and base course beneath portland cement concrete pavement shall be prepared in accordance with the applicable Sections of these Specifications and referenced Standard Specifications, except that the Contractor shall use an approved automatically controlled fine grading machine to produce final subgrade and base surfaces meeting the lines, grades, and cross sections (thicknesses) shown on the Drawings or established by the Engineer.
- B. The surface of the base shall be damp at the time the concrete is placed. The Contractor shall sprinkle the base when necessary to provide a damp surface. The Contractor shall satisfactorily correct all soft areas in the subgrade or base prior to placing concrete.
- C. Hauling over the base course shall not be allowed except where specifically permitted by and in writing by the Engineer. The Engineer may allow equipment dumping concrete to operate on the base to the extent and under the conditions the Engineer deems necessary to facilitate placing and spreading the concrete.
- D. Installation of the rigid concrete pavement shall be in accordance with the details shown on the Drawings and Division 03 - Concrete. The rigid concrete pavement shall cure a minimum of ten (10) calendar days and until the concrete has attained a minimum flexural strength of 550 psi as indicated by flexural strength testing. The Contractor shall coordinate and pay for all flexural strength testing with a minimum of four (4) 6-inch by 6-inch by 20-inch beams for every fifty (50) cubic yards of pavement concrete installed.
- E. Transverse and longitudinal joints shall be spaced at intervals as shown on the Drawings. Transverse contraction joints shall be formed by an approved joint insert. Longitudinal joints shall be formed by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver. Expansion joints shall be placed when the pavement abuts a structure using 1 inch expansion joint material (filler) and sealant as specified herein.

3.10 CONCRETE CURB AND GUTTER AND SIDEWALK

- A. The expansion joint filler for concrete curb and gutters shall be cut to conform with the cross section of the curb. Expansion joints shall be spaced at intervals of not more than 50 feet. Formed control joints shall be installed at intervals not exceeding 10 feet. (Expansion joints can be placed at intervals of 45 feet and control joints at 15 feet if curb and gutter is machine placed.) Depth of joint shall be 1/3 the thickness. Curved forms shall be used where radii are indicated; straight segments shall not be permitted. Upon removal of the forms, exposed curb faces shall be immediately rubbed down to a smooth and uniform surface. No plastering shall be permitted.
- B. Concrete sidewalks shall include contraction joints between each panel of sidewalk and when sidewalk width exceeds 6-feet, longitudinal contraction joints shall be placed as

required. Additionally, ½" expansion joints and sealer shall be placed at a maximum spacing of 50-feet of sidewalk. ½" expansion joint material and sealer shall also be where sidewalks abut and rigid structure or curb and gutter.

3.11 UNDERGROUND UTILITY LINES

- A. Where an underground utility line is beneath the new roadway, the backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of the roadway over the trench shall be deferred as long as practicable.

3.12 JUNCTION WITH OTHER PAVING

- A. Where new asphalt concrete pavement abuts existing asphalt concrete pavement, the existing pavement shall be cut back to insure obtaining the specified compaction of the new pavement courses and interlocking adjoining courses. Existing subbase courses shall be cut back from the subgrade level of the new pavement on a one-on-one slope into the existing pavement, and the asphalt courses of the existing pavement shall be removed for an additional 6-inches back from the slope. The edge of the existing asphalt courses shall be saw cut straight and true. The faces between new and existing asphalt courses shall receive an application of tack coat.
- B. Where new rigid concrete pavement abuts existing rigid concrete or asphalt concrete paving, the existing paving shall be saw cut straight and true. An expansion joint of a 1/2-inch minimum thickness with filler material and sealant shall be placed between the new concrete pavement and the existing rigid concrete or asphalt concrete paving.

3.13 ASPHALT CONCRETE OVERLAY

- A. Where asphalt concrete is proposed to be placed over an existing asphalt or rigid concrete surface, the surfaces shall be thoroughly cleaned by power brooming and a tack coat shall be applied in accordance with Utah Department of Transportation Standard Specifications and Standard Drawings., prior to installing the overlay. The overlay shall be applied in accordance with Subsections 2.06 and 3.05 and Standard Details shown on the Drawings.

END OF SECTION

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**SECTION 32 11 00
SURFACE RESTORATION**

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 00 01 – Earthwork
- B. Section 31 25 00 – Erosion and Sedimentation Control
- C. Section 32 90 00 – Final Grading and Landscaping

PART 2 – MATERIALS

2.01 TOPSOIL

- A. Topsoil shall meet the requirements of Section 31 00 01 – Earthwork.

PART 3 – EXECUTION

3.01 FINAL GRADING

- A. Following approval of rough grading the subgrade shall be prepared as follows:
 - 1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.
 - 2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

- A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped.
- B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.

- C. Topsoil shall not be placed in a frozen or muddy condition.
- D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.
- E. All stones, roots over 4-inches, rubbish, and other deleterious materials shall be removed and disposed of.

END OF SECTION

SECTION 32 31 13
STEEL FENCING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install steel fencing, posts, gates, etc., where shown on the Drawings and in compliance with these Specifications.
- B. Fencing shall be of the chain link type topped with barbed wire. The 6foot high fabric shall clear the final grade by 2 inches and shall be topped with three strands of barbed wire. The barbed wire shall be angled outward at the top. All components which are to be galvanized shall be hot dipped galvanized, coating to be 1.8 ounces per square foot of surface. Alternate coatings which employ a zinc coating of less than 1.8 ounces per square foot are not acceptable.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 30 00 – Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Shop Drawings shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 – PRODUCTS

2.01 CHAIN LINK FABRIC

- A. Fabric shall be 9-gauge aluminum coated wire woven in a 2-inch diamond mesh conforming to ASTM A491. Top and bottom selvage to have a barbed finish. Minimum weight of coating shall be 0.40 ounce per square foot of wire surface. The coated wire shall have a minimum tensile strength of 80,000 lbs. per square inch.
- B. Install fabric 3 inches above ground level. Fence shall be stretched tight and securely fastened to posts at points spaced 12 inches apart maximum.

2.02 POSTS

- A. Posts and rails shall be galvanized standard weight pipe conforming to the requirements of ASTM F1083.

1. Line Posts: Line posts shall be Schedule 40, 2-7/8 inch O.D. galvanized pipe with minimum bending strength of 201 pounds under a 6-foot cantilever load. Line posts shall be spaced at a maximum 10-foot O.C.
2. Terminal Posts: All end, corner, intermediate, and pull posts and gate leaves 6'0" wide and less shall be 3-½ inch O.D. galvanized Schedule 40 pipe with minimum bending strength of 381 pounds on 6-foot cantilever load. Gate posts for gate leaves shall be Schedule 40 pipe complying with ASTM F1083 of diameters as follows:

Gate Leaf Width	Pipe O.D.	Weight per Ft.
0' to 6'	3-1/2"	9.11 lbs.
Over 6' to 13'	4"	10.79 lbs.
Over 13' to 18'	6-5/8"	18.97 lbs.
Over 18'	8-5/8"	24.7 lbs.

2.03 TENSION WIRE

- A. Top and bottom tension wire shall be No. 7 gauge aluminum coated steel wire. Fabric shall be securely tied to tension wire at intervals not to exceed 24-inches.

2.04 POST TOPS AND BARBED WIRE SUPPORTS

- A. Gate, end, corner and line post tops shall be malleable iron or pressed steel and shall be hot dipped galvanized conforming to ASTM A153.
- B. Extension arms for supporting the three (3) strands of barbed wire for line posts shall be of pressed steel with malleable iron base, or solid aluminum alloy castings.
- C. Angles for line post extension arms shall be approximately 45 degrees from the vertical and the top slot for barbed wire shall be a minimum of 12 inches above the fabric and a minimum of 10 inches from the fence line.

2.05 BARBED WIRE

- A. Barbed wire shall consist of three strands of 12-1/2 gauge aluminum coated steel wire with 4-point barbs of 14 gauge aluminum wire spaced 5 inches apart, conforming to ASTM A585.
- B. Additional strands of barbed wire shall be added beneath the chain link fabric at all ditch crossings to maintain the security of the fence installation.

2.06 BRACES AND TOP RAILS

- A. Braces and top rails (where shown on the Drawings) shall be 1.66-inch O.D., Schedule 40 galvanized pipe with minimum vertical bending strength of 202 pounds on 10-foot span.
- B. Top rails shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion. Brace rails shall be provided at all terminal posts, located between the top and grade lines and extend from the terminal post to the first adjacent post. Braces shall be securely fastened at both ends. Brace ends for receiving brace rails shall be malleable iron or castings of 356.0 (formerly SG70A) alloy, or equivalent of ASTM B26 or B108.
- C. Truss and stretcher bands shall be 1/8-inch x 7/8-inch pressed steel, supplied with carriage bolts and nuts. Bolts shall be 5/16-inch by 1 1/4-inch. Truss rods shall be 3/8-inch nominal diameter.

2.07 FABRIC TIES

- A. Wire ties shall be pre-formed 0.148-inch diameter (9 gauge) aluminum. Flat band type ties shall be 1100-H18 or 3003-H14, .064-inch thick by 1/2-inch wide.
- B. Hog rings for attaching tension wire to fabric shall be 0.105-inch diameter, Alloy 1100-H14.

2.08 GATES

- A. Gate frames shall be made of 2-inch O.D. ASTM F1083 pipe, 2.72 lbs. per foot hot dipped galvanized. Fabric shall match fence. Gate frames shall be welded or assembled with riveted corner castings. Gate frames shall be equipped with 3/8-inch diameter adjustable truss bars. Hinges shall be ball and socket.
- B. Gate shall be equipped with positive latching device with provision for padlocking. Personnel gates shall be minimum 36-inch clear opening.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All line posts shall be spaced equidistant in the fence line on a maximum of 10-foot centers. Posts shall be set plumb in concrete bases as detailed on Drawings. The top of the posts shall be brought to a smooth grade line. The wire fence shall be set accurately to line and grade and shall be plumb.

- B. End, corner, pull or intermediate posts shall be placed in the following locations: corners; changes in direction; abrupt changes in grade; intervals no greater than 500 feet in the fence line. Each end or gate post shall have one brace assembly and each corner or intermediate post shall have two brace assemblies.
- C. Horizontal braces shall be provided at all terminal posts, corner posts, and intermediate posts between top rail and ground and shall extend from the above-mentioned posts to the first adjacent line posts. Braces shall be securely fastened to the line posts by brace ends and brace bands and to the terminal posts by approved rail end connectors. Diagonal brace rods shall be trussed from the brace end on the line post back to the terminal post, corner post or intermediate post and fastened to it by an approved connector.

3.02 POST FOUNDATIONS

- A. Post holes shall be in true alignment and of sufficient size to provide a permanent foundation of concrete. Holes shall be well centered on the posts. A minimum diameter of 12 inches shall be required for all posts.
- B. Post foundations shall be carefully rodded or tamped into place. The top of concrete shall extend 2 inches above ground line and shall be neatly troweled and leveled up from edges to the posts so as to have a pitch outward in all directions.
- C. No materials shall be installed on the posts, nor shall any load be applied to the posts within 3 days after the individual post foundation is completed.
- D. All concrete shall be Class "B" in conformance with Section 03 30 00 – Cast-in-Place Concrete.

3.03 RESETTING OF EXISTING FENCE

- A. Where shown on the Drawings that resetting of existing fence is required, the fence, after resetting, shall be in a condition that is equal to or better than before the fence was removed.
- B. The Contractor shall replace any of the fence components which have been unnecessarily damaged by him.

3.04 TEMPORARY FENCING

- A. The Contractor shall furnish and install all temporary fencing and appurtenances as shown on the Drawings or as required during construction to adequately secure the site prior to installation of the permanent fence.

END OF SECTION

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SECTION 32 90 00
FINAL GRADING AND LANDSCAPING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, equipment, and materials necessary for final grading, topsoiling, seeding, and miscellaneous site work not included under other Sections, but required to complete the work as shown on the Drawings and specified herein. Under this Section, all areas of the project site disturbed by excavation, materials storage, temporary roads, etc., shall be reseeded as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 00 01 - Earthwork
- B. Section 31 25 00 – Erosion and Sedimentation Control
- C. Section 32 11 00 – Surface Restoration

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures:
 - 1. Product Data
 - 2. Certification of all materials
 - 3. Three (3) copies of soils test report with fertilizer recommendation (or biotic soil amendment recommendation, if applicable) from the Utah Department of Agriculture and Food.
 - 4. Three (3) copies of composition and germination certification and of test results for grass seed.
 - 5. Biotic soil amendment manufacturer's product data and installation instructions. Include required substrate preparation, list of materials and application rate, if applicable.

PART 2 – PRODUCTS

2.01 CONTRACTOR'S RESPONSIBILITIES

- C. Furnish and submit certification for the materials used as specified in the General Conditions, Division 01..

2.02 TOPSOIL

- A. Upon completion and approval of the rough grading, the Contractor shall place the topsoil over all areas disturbed during construction under any contract except those areas which will be paved, graveled, rip rapped, or otherwise covered with an impervious surface. Topsoil shall be tested and amended as necessary according to the requirements of Section 31 00 01 – Earthwork prior to being placed over the site. Topsoil shall not be placed in a frozen or muddy condition and shall contain no toxic materials harmful to grass growth.

2.03 WATER

- A. Water shall be furnished to the Contractor by the Owner from existing facilities as directed by the Engineer.
- B. The Contractor shall furnish all hoses and connections necessary to complete the landscaping work.

2.04 FERTILIZER

- C. Fertilizer shall be a complete commercial fertilizer with components derived from commercial sources. Fertilizer analysis shall be determined from field soil sampling in appropriate number taken by the Contractor and analyzed by the Utah Department of Agriculture and Food or other independent laboratory. Contractor shall furnish fertilizer in accordance with the recommendations of the Utah Department of Agriculture and Food.
- D. One-quarter of the Nitrogen shall be in the form of nitrates, one-quarter in the form of ammonia salts, and one-half in the form of natural organic Nitrogen. Available Phosphoric Acid shall be free from superphosphate, bone, or tankage. Potash shall be Sulphate of Potash. Elements shall conform to the standards of Association of Official Agricultural Chemists.
- E. Fertilizer shall be delivered in standard size bags marked with the weight, analysis of contents, and the name of the manufacturer. Fertilizer shall be stored in weatherproof storage areas and in such a manner that its effectiveness will not be impaired.

2.05 LIME

- A. At least 50% shall pass a No. 200 U.S.S. mesh sieve. At least 90% shall pass a No. 100 U.S.S. mesh sieve and 100% shall pass a No. 10 U.S.S. mesh sieve. Total carbonates shall not be less than 80% or 44.8% Calcium Oxide equivalent. For the purpose of calculation, total carbonates shall be considered as Calcium Carbonate.

2.06 GRASS SEED

- C. The Contractor shall furnish the kinds and amounts of temporary and permanent seed to be planted in all areas disturbed by the construction work. All seed must have been tested within six (6) months immediately preceding the planting of such material on the job.
- D. Contractor may submit alternate grass seed types, rates, and planting dates specific to the project site based on consultation with, and the recommendations of, the Utah Department of Agriculture and Food, a local Soil Conservation District, local Agricultural Extension Program, or other qualified organization for approval by the Engineer before planting.
- E. The inoculant for treating legume seed shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species. Inoculants shall not be used later than the date indicated on the container. The quality of the seed shall conform to the following:

Type	Minimum Seed Purity (%)	Minimum Germination (%)	Maximum Weed Seed (%)
Fescue (fungus free)	98	90	1.00
Hybrid Rye	98	85	0.10
German Millet	98	85	0.50
Browntop Millet	98	85	0.50

- F. Seed mixtures to be used on the project shall be as follows:

Permanent Seeding	IFA Dry Pasture Mix
Temporary Winter Seeding	120#/acre Hybrid Rye (<i>Lolium multiflorum</i>) and 50#/acre German Millet (<i>Secale cereale</i>)
Temporary Summer Seeding	40#/acre Browntop Millet (<i>Urochloa ramosa</i>) or 50#/acre German Millet (<i>Setaria Italica</i>)

2.07 WOOD CELLULOSE FIBER MULCH

- A. For use in hydroseeding grass seed in combination with fertilizers and other approved additions, shall consist of especially prepared wood cellulose fibers such as "Wood-Lok 300" manufactured by Applegate Mulch, "Enviro-Mix" manufactured by Profile, or equal, and have no growth or germination inhibiting factors, and be dyed green.
- B. The wood cellulose fiber shall have the additional characteristic of dispersing rapidly in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit, or adequate equal, with the specified materials.
- C. When applied, the wood cellulose fiber with additives will form an absorptive mat but not a plant inhibiting membrane, which will allow moisture, natural or mechanical, to percolate into underlying soil.
- D. The mulch shall be supplied, compressed in packages containing 50 pounds of material having an equilibrium air dry moisture content at time of manufacture of 12% plus or minus 3%. Wood cellulose fiber mulch shall be stored in a weatherproof storage area and in such a manner that effectiveness will not be impaired.

2.08 STRAW MULCH

- A. Straw mulch shall be spread manually or by use of a straw blower. Straw used for mulch shall be small grain hay. Hay shall be undamaged, air dry, threshed straw, free of undesirable weed seed. Straw mulch is not required for seeded areas treated by hydroseeding or with a temporary soil stabilizer.
- B. Tackifier for securing straw mulch shall be Contact AT manufactured by Profile Products, M-Binder manufactured by Granite Seed, or Lawn Tack as manufactured by Rhino, or approved equal.

2.09 BIOTIC SOIL AMMENDMENT

- A. Contractor may submit to the Engineer for approval a biotic soil amendment as a biodegradable supplement or alternative to topsoil.
- C. Contactor shall take the recommended number of soil samples and send to a third-party, independent lab (such as the Utah Department of Agriculture and Food) for analysis. The tests shall include analysis and interpretation of results.
- C. Soil Analysis shall include results for:
 - 1. Soil pH
 - 2. Soluble Salts
 - 3. Excess Carbonate

4. Organic Matter
 5. Nutrient readings for:
 - i. Nitrogen, Phosphorus, Potassium
 - ii. Magnesium, Calcium, Sodium, Manganese, Sulfur, Zinc, Copper, Iron, Boron
 6. Cation Exchange Capacity
 7. Percent Base Saturation Sodium
- D. Based on soil test results, and as recommended by biotic soil amendment Manufacturer, Contractor shall submit recommended biotic soil amendment or other amendments to be applied with the hydroseeding slurry at Manufacturer recommended rates.
- E. Contractor shall submit to the Engineer for approval a selection of suitable plant species for achieving sustainable growth and effective erosion control once soils have been analyzed for agronomic potential and amendment recommendations, Seed selection shall be performed by a qualified seed supplier, consulting professional and/or regulatory agency, such as the Utah Department of Agriculture and Food.
- F. Contractor shall retain a manufacturer's representative to be on-site to oversee and approve the initial biotic soil amendment installation. Contractor shall submit a letter from the manufacturer approving the installation and application to the Engineer.
- G. Biotic soil amendments shall be ProGanics BSM as manufactured by Profile, Soil Boost as manufactured by SoilBiotics. Organix as manufactured by LSC Environmental Products, LLC, or approved equal.

2.10 TEMPORARY SOIL STABILIZER

- A. Temporary soil stabilizers may be used in place of temporary seeding, as approved by the Owner or Engineer. The temporary agent for soil erosion control shall consist of an especially prepared plant-based or cementitious highly concentrated powder which, when mixed with water, forms a thick liquid such as "DustOut" manufactured by DustOut™, "Stabilizer" manufactured by Stabilizer Solutions, or "SoiLok™" as manufactured by Prime Resins, or equal, and having no growth or germination inhibiting factors. The agent shall be used for bare soil stabilization or hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a wind and rain resistant crust.

2.11 ROLLED EROSION CONTROL MATTINGS

- A. The rolled erosion control products (RECMs) shall be as specified in Section 31 25 00 – Erosion and Sedimentation Control.

2.12 RIPRAP AND HERBICIDES

- A. Furnish and install sufficient quantity of landscape gravel or riprap to cover over the ground to a minimum 4-inch depth for gravel and 24-inch depth for riprap, unless

otherwise noted, or indicated on the Drawings. Also furnish and apply an approved herbicide to the subgrade surface just prior to installing the landscape gravel or riprap.

- B. During placing, the stone shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone.
- C. All topsoil and vegetative matter shall be removed from the subgrade surfaces prior to the application of the weed killer (herbicide) and to the placement of landscape gravel or riprap. Apply commercial-type herbicide as preemergence control of miscellaneous grasses and broadleaf weeds in granular or liquid form such as "Treflan", "Dymid", or equal. Methods and rates of application shall be in strict compliance to manufacturer's directions and acceptable to the Engineer.
- D. The herbicide selected shall be safe for use around ornamental plantings, have long-lasting weed control, and shall be resistant to leaching away under excessive rainfall.
- E. A second application of the herbicide shall be made on the surface of the landscape gravel or riprap sometime after the first six (6) months, but not later than 12-months. Same methods and rates apply as specified previously.

PART 3 – EXECUTION

3.01 GRADING

- A. After approval of the rough grading, the Contractor shall commence preparations of the subgrade for the various major conditions of the work as follows:
 - 1. Bare soil for riprap area at subgrade (24-inches below final grade, or as directed by the Engineer).
 - 2. Topsoil for lawn and road shoulder seed area - scarify 2-inch depth of subgrade (4-inches below final grade) prior to placing topsoil.
- B. Final surface grading of the top-soiled, landscape graveled, and riprapped areas shall be mechanically raked or hand raked to an even finished surface alignment.

3.02 TOPSOIL

- A. Topsoil shall be spread in place for quantity required for lawn and road shoulder seed areas at 4-inch consolidated depth, and sufficient quantity for certain plant beds and backfill for shrubs and trees as specified.

3.03 SEEDBED PREPARATION

- A. Contractor shall prepare all areas to receive temporary or permanent seeding measures prior to planting.
- B. Topsoil shall be placed in areas to be seeded and roughened with tracked equipment or other suitable measures. Slopes steeper than 3:1 may be roughened by grooving, furrowing, tracking, or stairstep grading. Slopes flatter than 3:1 should be grooved by disking, harrowing, raking, operating planting equipment on the contour.
- C. Soil amendments including, but not limited to, lime and fertilizer shall be spread as necessary, and at the rates specified in this Section. Seeding shall be as per the type and rates specified in this Section. Seed shall be broadcast as soon as possible following roughening and before surface has been sealed by rainfall.

3.04 GRASS ESTABLISHMENT AND HYDROSEEDING

- A. Prepare of the topsoil and bare soil seed bed, application of biotic soil amendment (if submitted), applicator fertilizer, limestone, mulching, inoculant, temporary soil stabilizer, water, and all other operations necessary to provide a satisfactory growth of sod at the end of the one year maintenance period. Areas without satisfactory sod at the end of one (1) year shall be replanted until satisfactory growth is obtained and acceptable to the Engineer.
- B. For areas to be seeded by the hydraulic seeding method, include all additives and amendments required. a "Reinco", "Finn", or "Bowie" type hydromulcher with adjustable nozzles and extension hoses, or equal, shall be utilized. general capacity of tank should range from 500 to 2,500 gallons, or as approved by the engineer.
- C. Hydraulic seeding shall be carried out in three steps. Step one shall consist of the application of lime. In step two the seed mixture shall be mixed with the biotic soil amendment (if used), fertilizer, wood cellulose fiber mulch, and any required inoculants and applied to the seed bed. Step three shall consist of an application of top dressing during the first spring or fall, whichever comes first, after step two.
- D. Top dressing shall consist of a commercial grade fertilizer plus Nitrogen or other analysis as may be recommended by soil testing. Contractor shall submit results of soils testing and recommendations to Engineer for review before applying top dressing. Types and application rates of seed mixtures, lime, fertilizer, and wood cellulose fiber mulch shall be as shown in the Seeding Schedule.
- E. Ingredients for the mixture and steps should be dumped into a tank of water and thoroughly mixed to a homogeneous slurry and sprayed out under a minimum pressure as recommended by the Manufacturer, in suitable proportions to accommodate the type and capacity of the hydraulic machine to be used. Applications shall be evenly sprayed over the ground surface. The Contractor shall free the topsoil of stones, roots, rubbish,

and other deleterious materials and dispose of same off the site. The bare soil, except existing steep embankment area, shall be rough raked to remove stones, roots, and rubbish over 4-inches in size, and other deleterious materials and dispose of same off the site.

- F. No seeding should be undertaken in windy or unfavorable weather, when the ground is too wet to rake easily, when it is in a frozen condition, or too dry. Any bare spots shown in two to three weeks shall be recultivated, fertilized at half the rate, raked, seeded, and mulched again by mechanical or hand broadcast method acceptable to the Engineer.
- G. Areas that have been manually seeded or hydroseeded with a temporary seed mixture shall be mowed to a height of less than 2 inches and scarified prior to hydroseeding with the permanent seed mixture.
- H. The Contractor shall provide, at the Contractor's own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.
- I. The Contractor shall water newly seeded areas of the lawn and road shoulder mix once a week until the grasses have germinated sufficiently to produce a healthy turf (a minimum of 80% ground coverage), or unless otherwise directed by the Engineer. Each watering shall provide three (3) gallons per square yard. The Contractor shall furnish all necessary hoses, sprinklers, and connections.
- J. The first and second cutting of the lawn grasses only shall be done by the Contractor. All subsequent cuttings will be done by the Owner's forces in a manner specified by the Contractor.

3.05 DITCH AND SWALE EROSION PROTECTION

- A. All ditches and swales indicated on the Drawings shall be lined with a rolled erosion control matting (RECM). The area to be covered shall be properly graded and hydroseeded before the RECM is installed. Installation shall be in accordance with Section 31 25 00 – Erosion and Sedimentation Control.

3.06 MAINTENANCE

- A. The Contractor shall be responsible for maintaining all seeded areas through the end of a one-year warranty period, beginning from the date of acceptance of final seeding and landscaping as determined by the Engineer. Maintenance shall include but not be limited to, annual fertilization, mowing, repair of seeded areas, irrigation, and weed control. The Contractor shall provide, at the Contractor's own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.

- B. Annual fertilization shall consist of an application of 500#/acre of 10-10-10 commercial grade fertilizer, or its equivalent and 60#/acre of nitrogen in early fall, or other analysis as may be determined by soil test. Annual fertilization shall be in addition to top dressing and shall be performed by the Contractor each fall season after planting until the work is substantially complete.
- C. Mowing shall be scheduled to maintain a minimum stand height of 4-inches or as directed by the Engineer. Stand height shall be allowed to reach 8 to 10-inches prior to mowing.
- D. All seeded areas shall be inspected on a regular basis and any necessary repairs or reseedings made within the planting season, if possible. If the stand should be over 20% damaged, it shall be re-established following the original seeding recommendations.
- E. Weed growth shall be maintained mechanically and/or with herbicides. When chemicals are used, the Contractor shall adhere strictly to the instructions on the label of the herbicide. No herbicide shall be used without prior approval of the Engineer.

3.07 CLEANUP

- A. The Contractor shall remove from the site all subsoil excavated from their work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.
- B. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

3.08 SEEDING SCHEDULE

- C. All seeding and mulching to be completed by the Contractor shall conform to the following schedule. No permanent seeding shall be performed from June 1 – August 31 and November 1 – February 14. Temporary seed mixtures will be used during these times if seeding is necessary. Areas seeded with temporary seed mixtures shall be reseeded by the Contractor at no additional cost to the Owner with permanent seed as directed by the Engineer.
- D. Application rates of seed mixtures, lime, fertilizer, mulch and top dressing are shown in the schedule.

SEEDING SCHEDULE

Application Rates (Pounds/Acre)								
Seed Mixture	Planting Season	Lime ^a	Seed ^b	Fertilizer	Straw ^c Mulch	Topdressing ^a	Annual Fertilizer	Comments
P	Feb. 15- 30 Sept. 1-Oct. 31	4000	150	1000	4000	500 of 10-10-10 60 of Nitrogen	Same as Topdressing	Preferred planting seasons are Sept. 1 – Sept. 30 and Feb. 15 – March 30.
TW	Jan. 1-May 1	2000	170	750	4000	-	-	Over seed with Type P seed mixture during next planting season.
TS	May 1-Aug. 15	2000	40	750	4000	-	-	Over seed with Type P seed mixture during next planting season.
TF	Aug. 15-Dec. 30	2000	120	1000	4000	-	-	Over seed with Type P seed mixture during next planting season.

Notes:

- a. Application rates and/or chemical analysis shall be confirmed or established by soil test.
- b. On cut and fill slopes 2:1 or steeper, add 30#/acre German Millet or Browntop Millet to Type P seed mixture.
- c. Apply tackifier at rate of 0.10 gallon per square yard (10 gal/1000 ft²), or as recommended by manufacturer, to tack straw mulch.

END OF SECTION

SECTION 33 01 10.59
WATER STORAGE TANK DISINFECTION

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The work under this Section includes providing for a complete and comprehensive flushing, testing, and disinfection program for a water storage tank, as specified herein.
- B. Before being placed into service and before Certification of Substantial Completion can be issued by the Engineer, the tank and all new potable water systems shall be disinfected in accordance to the requirements of these Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 – Submittal Procedures
- B. Section 40 05 00 – Basic Mechanical Requirements

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Shall be as specified in Section 01 42 00 – References
- B. AWWA D100 – Welded Steel Tanks for Water Storage
- C. AWWA C652 – Disinfection of Water Storage Facilities

PART 2 – EXECUTION

2.01 WATER SUPPLY

- A. The Owner will provide reasonable quantities of water necessary for flushing, testing, and disinfection of all facilities associated with this Project. All pipelines and the tank shall be filled slowly either through an existing valve or through taps. Special care shall be exercised in loading lines and filling the tank to prevent damage. The Contractor shall coordinate with the Owner the operation of all existing valves. All valve operations shall be done by the Owner's personnel only.

2.02 SCHEDULING

- A. The Contractor shall provide the Engineer with a detailed flushing, testing, and disinfection plan for approval. The Engineer reserves the right to adjust, modify, and/or alter the proposed plan to serve the best interests of the Owner at no additional cost to the Owner.

- B. The Contractor shall give the Owner, through the Engineer, at least 1-week advance notice of his intent to begin flushing, testing and disinfecting any portion of the system.
- C. All flushing, testing and disinfection shall be witnessed by the Engineer and a representative of the Owner. The Contractor shall coordinate all work with the Engineer at a time mutually agreeable to the Owner and shall give at least 24 hours advance notice prior to performing any work.

2.03 FLUSHING

- A. The Contractor shall flush all facilities described herein in accordance with these Specifications. The times for flushing shall be coordinated through the Engineer, with the Owner, for their ability to provide adequate water. The Contractor shall have no claim for monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of flushing. Compensation to the Contractor is limited to an extension of time to the Contract only.
- B. The Contractor shall prevent excessive water from flowing onto private property. Care shall be exercised to prevent the water from entering trenches or wetting backfill material. All materials shall be furnished by the Contractor.

2.04 TESTING

- A. The Contractor shall test the tank in accordance with the Specifications.

2.05 DISINFECTION

- A. The tank shall be disinfected in accordance with the procedures described in AWWA C652, Disinfection of Water Storage Facilities. Disinfection shall also be in accordance with the requirements of the Utah Department of Environmental Quality, Health and Human Services, and Natural Resources. and the Owner.
- B. Disinfection shall be accomplished after the tank has been flushed, if applicable, and passed the hydrostatic test. The tank shall be disinfected by any one or a combination of all three of the methods of chlorination identified in Section 4 of AWWA C652. The Contractor shall submit the proposed method to the Engineer prior to performing the work. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or the Owner until the minimum residual chlorine content has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to placing the tank in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. The Contractor shall pay all civil penalties, fines, costs, assessments, etc., associated with any discharge of spent chlorine solution associated with the Contractor's work. Chlorine residual tests will be made after flushing to assure that the chlorine residual is not in excess of 1 ppm.

- C. The Contractor shall have no claim for monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of disinfection. Compensation to the Contractor is limited to an extension of time to the Contract only.

PART 3 – EXECUTION - NOT USED

END OF SECTION

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SECTION 33 05 61
UTILITY STRUCTURES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03 21 00 – Reinforcing Steel
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. Section 03 60 00 – Grout
- D. Section 05 05 23 – Metal Fastening
- E. Section 31 00 01 - Earthwork
- F. Section 40 05 00 - Basic Mechanical Requirements

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
 - 1. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
 - 2. ASTM C139 - Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
 - 3. ASTM C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

4. ASTM C478 – Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
5. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
6. ASTM C858 – Standard Specification for Underground Precast Utility Structures
7. ASTM C890 – Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
8. ASTM C913 – Standard Specification for Precast Water and Wastewater Structures
9. ASTM C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
10. ASTM C990 – Standard Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
11. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
12. ASTM C1478 - Standard Specification for Storm Drain Resilient Connectors Between Reinforced Concrete Storm Sewer Structures, Pipes, and Laterals
13. ASTM C1802 - Standard Specification for Design, Testing, Manufacture, Selection, and Installation of Horizontal Fabricated Metal Access Hatches for Utility, Water, and Wastewater Structures
14. ASTM F2510 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes
15. ASCE/SEI 7-16 – Minimum Design Loads and Associated Criteria for Buildings and other Structures

1.04 SUBMITTALS

- A. Submit samples and/or Shop Drawings in accordance with Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings shall include, but not be limited to:
 1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.

2. Complete layout and installation Drawings and schedules with clearly marked dimensions.
3. Material certificates on all piping materials.
4. A list of the design criteria used by the manufacturer for all manufactured, precast items.
5. Structural design calculations sealed by a Professional Engineer registered in the State of Utah in which the project is located. Design calculations for precast manholes and vaults shall include confirmation structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure. The factor of safety for buoyancy due to groundwater conditions as noted above shall be 1.25. Factors of safety for other design conditions shall be as per ASCE 7-16, Section 4.2 - Safety Factors.
6. Certified reports for all lifting inserts, indicating allowable design loads.
7. Information on lifting and erection procedures.
8. Results of leakage test

PART 2 – PRODUCTS

2.01 PRECAST MANHOLES AND UTILITY STRUCTURES

- A. Design requirements vary for manholes, for utility structures exposed to internal liquid, and for utility structures not exposed to internal liquid, as follows:
 1. All precast manholes shall conform to the following requirements (regardless of exposure to internal liquid):
 - a. Precast manholes shall conform to the requirements of ASTM C478 and shall be designed for loads in accordance with ASTM C890.
 - b. Precast manholes shall be watertight for infiltration and exfiltration. Joints between manhole riser sections and at base slabs shall conform to the requirements of ASTM C443.
 - c. Manhole section shall have an internal diameter of 4'-0", unless noted otherwise. Clear lid openings shall be minimum of 24-inch diameter.
 2. Precast utility structures exposed to internal liquid (other than manholes) shall include but not be limited to water and wastewater distribution boxes, yard inlets, and catch basins. These structures shall conform to the following requirements:

- a. Precast utility structures exposed to internal liquid (other than manholes) shall conform to the requirements of ASTM C913 and shall be designed for loads in accordance with ASTM C890.
 - b. Precast utility structures exposed to internal liquid shall be watertight for infiltration and exfiltration. Joints between riser sections and at base slabs shall conform to the requirements of ASTM C443.
 3. Precast utility structures not exposed to internal liquid (other than manholes) shall include but not be limited to vaults and meter boxes for piping, and utility structures for electric, gas, or communication lines. These structures shall conform to the following requirements:
 - a. Precast utility structures not exposed to internal liquid (other than manholes) shall conform to the requirements of ASTM C858 and shall be designed for loads in accordance with ASTM C857.
 - b. Precast utility structures not exposed to internal liquid shall be soil-tight and shall be watertight for infiltration when below groundwater. Joints between riser sections and at base slabs shall conform to the requirements of either ASTM C443 or ASTM C990.
- B. In addition to the requirements above, the following requirements are typical for all precast manholes and utility structures:
1. Precast manholes and utility structures shall be furnished with sleeves and openings as noted on the Drawings, conforming accurately to the sizes and elevations of the adjoining pipes or conduits.
 2. Precast manholes and utility structures shall include ballast concrete and/or other means necessary to ensure they resist flotation when empty and subjected to groundwater full height of structure.
 3. Precast manholes and utility structures shall be as manufactured by Oldcastle, Tindall Corporation, or equal.
 4. The date and name of manufacturer shall be marked inside each precast section.
 5. No more than two lift holes may be cast or drilled in each section.
 6. Dimensions shall be as shown on the Drawings.
 7. Covers and frames shall be as specified in Paragraph 2.09.

8. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.

2.02 BRICK

- A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.

2.03 CONCRETE

- A. Concrete shall conform to Section 03 30 00 – Cast-in-Place Concrete.

2.04 REINFORCING

- A. Reinforcing shall conform to Section 03 21 00 – Reinforcing Steel.

2.05 CONCRETE BLOCK

- A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.

2.06 STEPS

- A. Steps shall be constructed of Grade 60 steel reinforcing rod (min. 1/2-inch) and completely encapsulated with a wear resistant and chemical resistant rubber.
- B. Each step shall have a minimum vertical load resistance of 800 pounds and a minimum pull-out resistance of 400 pounds.
- C. The steps shall have 11-inch minimum tread width and shall be placed at 16-inches on center, as shown on the Drawings.
- D. Steps shall be cast in place with the concrete.
- E. Steps shall only be installed as shown on the Drawings or required in the Specifications.

2.07 JOINT SEALANTS AND GASKETS

- A. For precast utility structure joints required to conform to ASTM C990, joint sealant shall be a preformed flexible sealant conforming to the requirements of ASTM C990, paragraph 6.2, Butyl Rubber Sealant. Joint sealant shall be Pro-Stik Butyl Sealant by Press-Seal Corporation, Butyl-Nek Join Sealant by Henry Company, CS-102 Butyl Rubber Sealant for all Precast Structures by ConSeal Concrete Sealants, Inc., or equal.

- B. For precast utility structure joints required to conform to ASTM C443, gaskets shall be rubber gaskets conforming to the requirements of ASTM C443.

2.08 PIPE TO MANHOLE CONNECTIONS

- A. The spring set type shall have a stainless-steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal® | 106-406 Series assembly by National Pollution Control Systems, or QUIK-LOK Boot Connector by A-LOK Products, Inc, or equal.
- B. The cast-in-place type shall conform to ASTM C923-18 for sanitary sewer connections between reinforced concrete manhole structures, pipes, and laterals, ASTM C1478-19 for storm drain connections between pipes, and laterals, and ASTM F2510 for storm drain connections between reinforced concrete manhole structures, and dual and triple-wall polyethylene and polypropylene pipes. Sleeves shall include stainless steel take up clamps.
- C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

2.09 COVERS AND FRAMES

- A. Manhole covers and frames shall meet the following requirements:
 - 1. Locate so that there is ready access to the manhole steps
 - 2. Clear opening shall be a minimum of 22 inches, unless otherwise indicated on the Drawings.
 - 3. Watertight manhole frames and covers shall be suitable for 20 psi internal pressure and shall be Neenah Model R-1915, Type E or equal, cast in place.
 - 4. Non-watertight manhole covers shall be perforated and shall be Neenah Model R-1668, or equal.
 - 5. Storm drain grated inlet frames and grates shall be Neenah R-1878-B7L, East Jordan Iron Works V-4873, or equal.
 - 6. Curb inlet frames and grates shall be Neenah R-3067, East Jordan Iron Works EJ 7030, or equal, and shall include frame, grate, and hood.
- B. Vault covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05 05 23 – Metal Fastening.

- C. The Load Level capacity of fabricated metal access hatches as noted on the Contract Drawings shall be in conformance with the requirements of ASTM C1802.
- D. Frames and covers shall be identical throughout the Contract.

2.10 CONCRETE BALLAST (SEE NOTE TO SPECIFIER BEFORE ARTICLE 2.04)

- A. Concrete ballast shall be Class B concrete in conformance with Section 03 30 00 – Cast-in-Place Concrete. Ballast shall be provided as necessary to ensure manhole resists flotation when empty and subjected to full height groundwater conditions.

2.11 EPOXY BONDING AGENT

- A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterEmaco ADH Series by Master Builders Solutions.

PART 3 – EXECUTION

3.01 DESIGN CRITERIA

- A. Minimum structural design loading for underground precast concrete manholes and utility structures shall be in accordance with the applicable document of ASTM C890 or ASTM C857 specified in Article 2.01, unless otherwise noted herein. Precast items subjected to vehicular traffic shall be designed for HS-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.
- B. Walls of precast items shall be designed for a vertical surcharge resulting in a 100 psf horizontal load.
- C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole/vault.

3.02 FABRICATION AND CASTING

- A. Fabrication and casting of precast manholes and utility structures shall conform to the applicable ASTM documents specified in Article 2.01.
- B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.
- C. Utility structures built around existing pipe shall have a cast-in-place base slab.

3.03 HANDLING, TRANSPORTING, AND STORING

- A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28-day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.
- B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.
- C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.
- D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.
- E. Precast concrete members shall not be used as storage areas for other materials or equipment.
- F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.04 INSTALLATION

- A. Installation of precast manholes and utility structures shall conform with the manufacturer's recommendations.
- B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.
- C. Joints between riser sections shall be sealed with joint sealant or gaskets as specified herein.
- D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.
- E. Openings that are too large for flexible rubber sleeves shall utilize rubber bladder seals which are expanded by water injected using a pressure pump.
- F. All units shall be installed plumb and level.
- G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03 60 00 – Grout, grout inside and out.

- H. The manhole frames shall be set to their required elevations either with grade rings or with two or three courses of brick masonry laid around the top of the upper wall section. Such brick work shall be given a 1-inch mortar coat on the inside and out.
- I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.
- J. Brick or Concrete Block
 - 1. Brick or concrete blocks shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. The outside of walls shall be plastered with a minimum 1-inch-thick coat of cement-sand mortar troweled smooth.
- K. Connection to Existing Pipe
 - 1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.
 - 2. Provide adequate protection to prevent damage to the existing pipe.
 - 3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.
 - 4. Cut off the existing pipe sufficiently for connection to the new structure and remove.
 - 5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.
 - 6. Install a flexible joint sealer around the pipe.
 - 7. Grout inside and outside of wall penetration with non-shrink grout.
- L. Backfill structures in accordance with Section 31 00 01 – Earthwork.
- M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.
- N. Excavation shall conform to Section 31 00 01 – Earthwork.
- O. Structure bases shall bear on a minimum of 8-inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.
2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.
3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

- A. Adjust structures as indicated on the Drawings using concrete or cast-iron adjustment rings by approved methods.
- B. Clean covers and inlet castings of all foreign material.

3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

- A. Adjusting collars shall be as shown on the Drawings, or as necessary meet final grade. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

3.07 LEAKAGE TESTING FOR MANHOLES

- A. All manholes shall be vacuum tested as specified below. Refer to Section 40 05 00 – Basic Mechanical Requirements for sanitary pipe testing methods and requirements.
- B. Manhole vacuum testing shall include the following minimum requirements:
 1. Testing shall be done in accordance with ASTM C1244 (latest revision).
 2. Prior to testing all pipes, holes, and vents entering manhole shall be plugged and braced.
 3. Contractor shall have an approved test head and copy of instructions for use by the manufacturer.
 4. Contractor shall furnish two (2) certified and calibrated vacuum test gauges for the test.

- a. A vacuum of 10-inch hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time for the vacuum pressure to drop to 9-inch hg shall be measured. If the test time meets or exceeds the test time as specified in Table 1, the manhole is acceptable; otherwise, the test has failed and the manhole should be checked for leaks, repaired, and re-tested.

Table 1
Minimum Vacuum Test Times (Seconds) for Various Manhole Diameters and Depths

Depth (ft)	Manholes Ø (inches)						
	48	60	72	84	96	108	120
6'	15	20	25	29	34	38	43
8	20	26	33	38	45	51	57
10	25	33	41	48	56	63	71
12	30	39	49	57	67	76	85
14	35	46	57	67	78	89	100
16	40	52	67	76	89	101	114
18	45	59	73	86	100	114	128
20	50	65	81	95	111	126	142
22	55	72	89	105	122	139	156
24	59	78	97	114	133	152	170
26	64	85	105	124	144	164	185
28	69	91	113	133	155	177	199
30	74	98	121	143	166	189	213
Add. VF	+2.5	+3.25	+4.0	+4.75	+5.5	+6.5	+7.0

3.08 FLUSHING AND TESTING OF SEWERS

- A. After backfilling, all sewers shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Engineer. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Contractor shall provide a means acceptable to the Engineer for removal of debris flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Contractor's expense.
- B. Visual Inspection – Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet

these qualifications. Any visual water infiltration of water into the manhole shall be repaired using hydraulic cement or other approved materials.

- C. Leakage – Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Contractor shall, at the Contractor's own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.
- D. Leakage Test Procedure – Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be reestablished and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.
 - 1. If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir or other measuring device approved by the Engineer. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.
 - 2. Where the actual leakage exceeds the allowable, the Contractor shall discover the cause and correct it before the sewer will be accepted. A section of sewer is defined as that length of sewer between successive manholes or special structures or stub-outs for future connections.
- E. Low Pressure Compressed Air Test – If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.
- F. Deflection Test – No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflectometer or a rigid "GoNoGo" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

1. Where the actual deflection exceeds the allowable, the Contractor shall discover the cause and correct before the pipe will be acceptable. A section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.
- G. Cost of Testing and Repairs – Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Contractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Contractor.
1. The Contractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the sewers.

END OF SECTION

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SECTION 33 71 19
UNDERGROUND ELECTRICAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install underground duct systems and electric handholes as specified herein and as indicated on the Drawings. The work shall be complete and shall include excavation, concrete construction, backfilling, and all materials, items, and components required for a complete system.
- B. The provisions of this Section are applicable to all underground conduit work. All work shall be coordinated with that of the various utility companies and other Contractors. The Contractor shall adhere to all utility company requirements including the serving electric utility.
- C. Reference the following Specification Sections:
 - 1. Section 26 05 00 – Basic Electrical Requirements
 - 2. Section 26 05 33.13 – Conduit for Electrical Systems
 - 3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 - 4. Applicable sections of Division 31, Earthwork
 - 5. Section 03 21 00 – Reinforcing Steel
 - 6. Section 03 30 00 – Cast-In-Place Concrete
 - 7. Section 33 05 61 – Utility Structures

1.02 CODES AND STANDARDS

- A. Products specified herein shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. AASHTO H20
 - 2. ANSI/SCTE 77-2010 – Specification for Underground Enclosure Integrity

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01 33 00 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit Shop Drawings. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to, the following:
 - 1. Product data sheets.
 - 2. Outline and dimensional drawings including detailed sections of handholes.
 - 3. Materials specifications and structural calculations for the handholes sealed by a Professional Engineer licensed in the State or Commonwealth in which
 - 4. the project is located.

1.05 IDENTIFICATION

- A. Each electric handhole cover shall be lettered with the word "Electric", the handhole identification number (e.g., UMH-1, EMH-1, EHH-1, etc.), manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

2.02 DUCT SYSTEM

- A. The underground duct system shall be comprised of conduits, conduit bends, and conduit fittings as specified in Section 26 05 33.13 – Conduit for Electrical Systems. Conduits shall be encased in reinforced concrete envelopes, unless otherwise specified herein or indicated on the Drawings.
- B. Base and intermediate conduit spacers shall be furnished to provide a minimum of two-inch (2") separation between conduits. Conduit spacers shall be provided in the proper size as required for the conduit that they secure. For example, a 4" conduit spacer shall not be used to secure a 2" conduit. Conduit spacers shall be as manufactured by Carlon Electrical Products Company, Aeroquip Corporation, Underground Devices, Incorporated, or Engineer approved equal.

2.03 ELECTRIC HANDHOLES

- A. The electric handholes shall be a precast polymer concrete enclosure suitable for use as part of an underground electric raceway system. The enclosure shall meet or exceed the requirements of ANSI/SCTE 77-2010.
- B. The enclosure and cover design and test load rating shall be Tier 15. Covers shall be provided with cover hooks.
- C. The enclosure shall be the straight side design to allow easy adjustment of box to grade. The box shall be stackable for increased depth.
- D. Handhole opening size shall be as required to suit the application, 6" x 8", minimum.
- E. The electric handholes shall be manufactured by Hubbell, Pencil Plastics equivalent, Highline Products equivalent, or Engineer approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. The underground duct system, and handholes shall be installed as specified herein, indicated on the Drawings, and in accordance with manufacturers' instructions.

3.02 DUCT SYSTEM

- A. All underground conduits shall be encased in concrete and shall be reinforced. Encasement and reinforcement shall be as indicated in the Standard Details. Concrete shall be furnished and installed in accordance with Section 03 30 00 – Cast-In-Place Concrete. Reinforcing steel shall be furnished and installed in accordance with Section 03 21 00 – Reinforcing Steel. Concrete electrical duct banks shall contain red dye; the

red dye shall be mixed into the concrete mix before being poured. Red dye applied to the top of concrete encasement after placement of concrete is not acceptable.

- B. Concrete pours shall be complete from handhole to handhole where practicable. Partial pours in general shall not be permitted. Where a complete pour is impractical, written authorization shall be obtained from the Engineer for the partial pour.
- C. Conduit ductbank elevations at the handholes shall be based on minimum ductbank cover as indicated in the Standard Details, or deeper to avoid conflicts with other obstacles. Where deviation is necessary to clear unforeseen obstacles, the elevations may be changed after authorization by the Engineer.
- D. Slope all conduits continuously away from structures and buildings with a minimum slope of 3" per 100' unless otherwise indicated on the Drawings.
- E. The minimum clearance from the top of the concrete encasement and finished grade shall be as indicated in the Standard Details, except where otherwise accepted in writing by the Engineer or shown on the Drawings.
- F. Care shall be exercised during excavation for the duct banks to prevent digging too deep. Backfilling of low spots with earth fill will not be permitted unless thoroughly compacted and acceptable to the Engineer.
- G. Where no specific ductbank arrangement is shown on the Drawings, the Contractor shall arrange conduits within each ductbank based on field conditions. Spare conduits shown going from ductbanks into buildings or structures shall be stubbed up in the location(s) as indicated on the Drawings.
- H. The ends of the bare copper cables embedded in the concrete ductbank shall be connected to structure and/or building ground rings where the ductbanks terminate, and to each other in handholes as specified herein.
- I. Care shall be exercised and temporary plugs shall be installed during installation to prevent the entrance of concrete, mortar, or other foreign matter into the conduit system. Conduit spacers shall be utilized to support conduit during the pouring of concrete to prevent movement and misalignment of the conduits. Conduit spacers shall be installed in accordance with manufacturer's instructions unless otherwise noted. Horizontal spacing of conduit spacers along ductbank shall be as indicated on the Standard Details.
- J. Where connections to existing underground conduits are indicated, excavate to the maximum depth necessary. After addressing the existing conductors, cut the conduits and remove loose concrete from the conduits before installing new concrete encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines.

- K. Construct concrete-encased conduits connecting to underground structures to have a flared section adjacent to the handhole to provide shear strength. Construct underground structures to provide shear strength. Construct underground structures to provide for keying the concrete encasement of the duct line into the wall of the structure. Use vibrators when this portion of the encasement is poured to ensure a seal between the encasement and the wall of the structure.
- L. Six (6) inches above all duct banks, the Contractor shall furnish and install a two (2) inch wide red plastic electrical hazard tape. Tapes shall be metallic detectable type and shall have a continuous message in bold black letters: "ELECTRIC LINE BURIED BELOW." Tape shall be Detectable Identoline by Brady or Engineer approved equal.
- M. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, shoring and bracing, grading, and restoration of surfaces and seeded areas disturbed during the execution of the Work.
- N. All conduit joints in the duct system shall be staggered such that adjacent conduits do not have joints in the same location.

3.03 ELECTRIC HANDHOLES

- A. Electric handholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 9" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to roof. All handholes shall be installed in accordance with Standard Detail E-33-0103.
- B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.
- C. All individual cables and/or bundles of conductors shall be identified and "dressed" along the wall of the enclosure. Cable racks as specified herein shall be provided if any handhole dimension exceeds 24 inches.

3.04 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:
 - 1. Field tests
 - a. Field tests for all completed duct systems shall consist of pulling a swab through each conduit followed by a mandrel equal in size to 85% of the conduit inside diameter.

- b. After testing, all conduits shall be capped after installation of a suitable pull rope. All field tests shall be witnessed by the Engineer.

END OF SECTION

SECTION 40 05 00
BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. Piping to be backfilled and/or encased in concrete is considered to be buried piping. Piping that is not buried is considered to be exposed.
- B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.
- C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.
- D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.
- E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.
- F. The work shall include, but not be limited to, the following:
 - 1. Connections to existing pipelines.
 - 2. Test excavations necessary to locate or verify existing pipe and appurtenances.
 - 3. Installation of all new pipe and materials required for a complete installation.
 - 4. Cleaning, testing and disinfecting as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 01 – General Requirements
- B. Division 05 – Metals
- C. Division 26 – Electrical
- D. Division 46 – Water and Wastewater Equipment

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

- A. The Contractor shall furnish to the Owner (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.
- B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01 33 00 – Submittal Procedures. In addition to the requirements of Section 01 33 00 – Submittal Procedures, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.
- C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Part 3.
- C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.

- D. All buried piping shall have restrained joints for thrust protection unless otherwise specified or shown on the Drawings. All exposed piping shall have flanged joints, unless otherwise specified or shown on the Drawings.
- E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 WALL PIPES

- A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

Pipe Size	Waterstop Flange Diameter	Waterstop Flange Thickness
4" - 12"	OD + 3.10"	0.50"
14" - 24"	OD + 4.15"	0.75"
30" - 36"	OD + 4.50"	1.00"
42" - 48"	OD + 5.00"	1.25"
54"	OD + 5.90"	1.50"

2.03 SLEEVES

- A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.
- B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of AISC and AWS.

- C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by Garlock Pipeline Technologies (GPT) or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 316 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and 316 stainless steel bolts and nuts.
- D. Cast iron mechanical joint adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to affect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

2.04 SOLID SLEEVE COUPLINGS (FOR BURIED SERVICE THROUGH 54-INCH)

- A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal. Solid sleeve couplings shall be restrained with wedge-type restraining glands to meet the pressures specified in 40 06 20 – Schedules.
- B. Alternatively, EBAA Iron 3800 Mega-Coupling is acceptable.

2.05 SLEEVE TYPE COUPLINGS (FOR EXPOSED SERVICE AND BURIED SERVICE ABOVE 54-INCH)

- A. Sleeve type, flexible couplings shall be furnished and installed where shown on the Drawings or otherwise required to resist internal operating pressures. In addition to that specified herein, harnessed, sleeve type flexible couplings shall be provided on all exposed pipe 3 inches and larger in diameter that spans any expansion joint in a building or structure.
- B. Materials shall be of high strength steel and couplings shall be rated for the same pressures as the connecting piping.
- C. Gaskets shall be rubber. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

- D. Harnessing for exposed applications shall be by rodding across the sleeve type coupling to the nearest pipe joint on either side of the coupling using threaded rods and rod tabs unless otherwise approved by the Engineer.
- E. Couplings shall be as manufactured by Smith-Blair Model 411, Romac Industries Model 400, Dresser Industries Style 38, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.
- F. Couplings shall be provided with manufacturer's fusion bonded epoxy painting system.

2.06 FLANGED COUPLING ADAPTERS

- A. Flanged coupling adapters shall be furnished as required and as shown on the Drawings.
- B. Flanged coupling adapters shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping.
- C. All flanged coupling adapters shall be harnessed by tying the adapter to the nearest pipe joint flange using threaded rods and rod tabs unless otherwise approved by the Engineer.
- D. Flanged coupling adapters shall be manufactured by Smith-Blair Model 912 or 913, Romac Industries Model FCG or FC 400, Dresser Industries Model 128-W, or equal.
- E. Flanged coupling adapters shall be provided with manufacturer's fusion bonded epoxy painting system.

2.07 DISMANTLING JOINTS

- A. Dismantling joints shall be furnished at locations shown on the Drawings.
- B. Dismantling joints for sizes less than 12-inch shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping. Dismantling joints for sizes greater than 12-inches shall be of carbon steel construction and shall be rated for the same pressure as the connected piping.
- C. Flanges for dismantling joints shall match the bolt pattern and pressure rating of the flanges for the connected piping.
- D. All dismantling joints shall be restrained utilizing restraining rods provided by the manufacturer. Restraining rods shall be constructed from ASTM A193 Grade B7 steel. Restraining rods and restraint system shall be installed in strict accordance with manufacturer's recommendations.
- E. Dismantling joints shall be provided with manufacturer's fusion bonded epoxy painting system.

- F. Dismantling joints shall be manufactured by Smith Blair Model 975, Romac Industries Model DJ400, or equal.

2.08 GROOVED COUPLINGS

- A. Grooved end pipe couplings shall be furnished as specified or shown on the Drawings.
- B. Materials shall be of malleable iron and couplings shall be rated for the same pressures as the connecting piping.
- C. Gaskets shall be rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated.
- D. After installation, buried couplings shall receive two heavy coats of an approved coal tar which is compatible with the finish of the coupling.
- E. Couplings shall be manufactured by Victaulic Company of America Style 31 or equal.

2.09 TAPPING SLEEVES AND TAPPING SADDLES

- A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.
- B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

2.10 UNIONS

- A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.
- B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.
- C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.11 THERMOPLASTIC TUBING AND FITTINGS

- A. Thermoplastic tubing shall be manufactured from polyallomer tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color

conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or equal. Brass sleeves shall be used.

- B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the manufacturer's recommendations. Thermoplastic tubing shall be the Impolene (polyallomor) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or equal.

2.12 HEAT TRACED PIPING

- A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing where indicated on the Drawings and in the Specifications. Heat tracing of piping shall be provided as specified in Section 40 06 20 – Process Pipe, Valve and Gate Schedules and in Section 40 41 13 – Heat Tracing Systems.

2.13 FLEXIBLE RESTRAINED EXPANSION JOINTS

- A. Restrained expansion joints shall be manufactured of 60-42-10 ductile iron conforming to material and other applicable requirements of ANSI/AWWA C153/A21.53.
- B. Each pressure containing component shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the materials requirements of, and tested in accordance with, ANSI/AWWA C213 and shall meet or exceed the requirements of ANSI/AWWA C550.
- C. Seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11.
- D. All bolts used in the assemblies shall be stainless steel and shall be coated with a premium quality epoxy.
- E. Flanged ends shall comply with ANSI/AWWA C110/A21.10, with the addition of O-ring groove and O-ring.
- F. Mechanical joint ends shall comply with ANSI/AWWA C153/A21.53.
- G. Restrained expansion joints shall have a minimum pressure rating of 350 psi with a minimum safety factor of 3:1. Each assembly shall be tested at 350 psi before shipment.
- H. Restrained expansion joints shall provide for self-restraint without tie rods and shall provide for expansion and contraction capabilities cast as an integral part of the end connection.

- I. Flexible restrained expansion joints shall allow for 8-inches (+6"-2") minimum expansion.
- J. Flexible restrained expansion joints shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15□ deflection per ball.
- K. Restrained expansion joints shall be the Single Ball or Double Ball FLEX-TEND Expansion Joint as manufactured by EBAA Iron Inc., or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.
- B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.
- C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

- D. ALL EXCAVATION REQUIRED BY THIS CONTRACT SHALL BE UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION REQUIRED FOR THE INSTALLATION OF PIPE OR STRUCTURES SHOWN ON THE DRAWINGS.
- E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.
- F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.
- G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.
- H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.
- I. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURER'S RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the requirements of Section 31 00 01 – Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.
- J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.
- K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe

ends left for future connections shall be valved, plugged, or capped, and anchored as required.

- L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.
- M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.
- N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.
- O. AT THE CLOSE OF EACH WORK DAY, THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP OR PLUG SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.
- P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.
- Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used exceptions: closure pieces at manholes and areas where joint deflection is required.
- R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.
- S. ALL PIPING SHALL HAVE TYPE "A" BEDDING AS SHOWN ON THE DRAWINGS, UNLESS OTHERWISE SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS.
- T. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water piping. The tape shall be blue and silver and shall be clearly and permanently labeled "Water". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.

- U. AT THE CLOSE OF WORK EACH DAY, PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED AS SPECIFIED IN SECTION 32 10 00 – PAVING AND SURFACING, TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.

3.02 CARBON AND STAINLESS STEEL PIPE

- A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.
- B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.
- C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.
 - 1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.
 - 2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.
 - 3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.
 - 4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

3.03 JOINTS IN PIPING

- A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

- B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed, and the condition corrected.
- C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.
- D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.
- E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.

- F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.
- G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.
- H. Copper joints shall be thoroughly cleaned and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.
- I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.
- J. Dielectric isolation such as flange isolation kits, dielectric unions, or similar, shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			•	•	•	•	•	•	•
Galvanized Steel			•	•	•	•	•	•	•
Aluminum	•	•		•	•	•	•	•	•

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Cast Iron	•	•	•				•	•	•
Ductile Iron	•	•	•				•	•	•
Mild Steel/ Carbon Steel	•	•	•				•	•	•
Copper	•	•	•	•	•	•			•
Brass	•	•	•	•	•	•			•
Stainless Steel	•	•	•	•	•	•	•	•	

Notes:

- signifies dielectric isolation is required between the two materials noted.
- Consult Engineer for items not listed in table.
- Provide flange isolation kits for all flanged connections of dissimilar metals and hardware including connections to equipment.
- Contractor shall include all isolation descriptions with piping submittals.

- K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.
- L. Joints in polypropylene and polyvinylidene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

3.04 FLUSHING AND TESTING

- A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested as specified in Section 33 05 61 – Utility Structures. Polymer piping shall be tested with mineral oil or as recommended by the polymer chemical supplier. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 40 06 20 – Process Pipe, Valve and Gate Schedules and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. Do not test exterior, exposed pipelines if air temperature is expected to fall

below 32 degrees F. The Engineer reserves the right, within reason, to request flushing and testing of any section or portion of a pipeline.

- B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.
- C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.
- D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 5.0 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.
- E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.
- F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.
- G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.
- H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.
- I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected and the test repeated until a successful test of the entire system is obtained.
- J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.

- K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 40 06 20 – Process Pipe, Valve and Gate Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.
- L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.
- M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

3.05 DISINFECTION OF PIPELINES

- A. Following acceptable pressure testing, flush and disinfect all sections of the water distribution system and receive approval thereof from the appropriate agencies, prior to placing in service. Do not disinfect exterior, exposed pipelines if air temperature is expected to fall below 32 degrees F. Advance notice of 24 hours shall be provided to the Owner and Engineer before disinfecting procedures start. The flushing and disinfection shall be accomplished in accordance with the applicable provisions of AWWA Standard C651, "Disinfecting Water Mains" and all appropriate approval agencies.
- B. Administration shall be by any of the several methods described in AWWA Standard C651 and as proposed by the Contractor and approved by the Owner and Engineer. Contractor shall submit a proposal describing the desired disinfection method, which shall be approved by the Owner and Engineer prior to commencement of the disinfection process.
- C. The initial chlorine dose shall be as described in AWWA C651 for the selected disinfection method. Chlorinated water must be retained in the pipeline long enough to destroy all non-spore forming bacteria, and not less than the retention time recommended for the selected disinfection method per AWWA C651. After the chlorine treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative locations shall be as described in AWWA C651 for the selected disinfection method.
- D. During the period that the chlorine solution or slug is in the section of pipeline, valves shall be opened and closed to obtain a chlorine residual at hydrants and other pipeline appurtenances. Care shall be taken to ensure that no chlorinated water enters any active pipeline.
- E. Following contact with chlorine solution, the system shall be thoroughly flushed out per Section 4.9 of AWWA C651. All highly chlorinated water shall be flushed out within 72 hours of filling the main with highly chlorinated water. Samples shall then be taken using

sterile containers obtained from the local regulatory agency. Samples shall be taken by the Contractor and delivered to the local regulatory agency or approved laboratory for analysis at the Contractor's expense.

- F. If samples test positive for coliform organisms, the disinfection procedure shall be repeated until two series of satisfactory samples are obtained, the period between such series of samples to be a minimum of 24 hours. Contractor is responsible for all costs associated with repeat tests. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. Bacteriological testing shall conform to Section 5 of AWWA C651.
- G. Chlorine residual tests will be performed after flushing to assure that residual is no higher than what is acceptable to the Owner based on the normal prevailing residual in the drinking water distribution system. Testing shall be performed at multiple locations throughout the piping system to verify residual values.
- H. Following disinfection, pipelines and appurtenances shall remain isolated from any operational water system facilities until evidence has been submitted to Owner demonstrating that the pipelines and appurtenances have been adequately and properly disinfected. Normally, pipelines and appurtenances shall be isolated for at least 48 hours, unless a longer period is dictated by the Owner.
- I. Sanitary construction methods must be followed during installation of the final connections so no contamination of the new or existing water main with foreign material or groundwater occurs. Materials used for final connections shall be disinfected in accordance with Section 4.10 of AWWA C651.
- J. All water used in testing and disinfecting the portions of pipeline, including that used for retesting, shall be disposed of following such testing, retesting, and disinfecting, by the Contractor at its own expense. If required by any agency having jurisdiction, the Contractor shall apply a reducing agent to the solution to neutralize residual chlorine or chloramines remaining in the water. The disposal of water shall, in all cases, be carried out in strict observance of the water pollution control requirements of the local and state regulatory agencies. The flow of water from the portions of the pipeline shall be controlled to prevent erosion of surrounding soil, damage to vegetation, and altering of ecological conditions in the area.

3.06 PAINTING AND COLOR-CODING SYSTEM

- A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 40 05 97 – Piping and Equipment Identification Systems.

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SECTION 40 05 07
PIPE SUPPORTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and design calculations required to provide pipe supports in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 73 23 – Anchorage and Bracing of Non-Structural Components
- B. Division 03 – Concrete
- C. Section 05 05 23 – Metal Fastening
- D. Section 05 10 00 – Metal Materials
- E. Section 05 50 00 – Metal Fabrications
- F. Section 40 05 00 – Basic Mechanical Requirements

1.03 SUBMITTALS

- A. Pipe support submittals will not be reviewed prior to review and acceptance of pipe layout submittal. Pipe support submittal shall be fully coordinated with approved pipe layout submittal. Contractor shall use approved piping layout submittal drawings to show proposed pipe support type and location with accurate dimensions to demonstrate that supports meet all specified requirements.
- B. Applicable and associated cut sheets and drawings for materials and support components shall be submitted with the Shop Drawings in accordance with or in addition to the submittal requirements specified in Section 01 33 00 – Submittals, Section 40 05 00 – Basic Mechanical Requirements and other referenced Sections above.

- 1. Catalog cut information on all system components such as pipe supports, hangers, guides, anchors, and channel-type supports.

2. Drawings of the piping support systems, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide and anchor type by catalog number and Shop Drawing detail number.
3. With each piping support system Shop Drawing, the Contractor shall attach calculations prepared and sealed by a Professional Engineer, licensed in the State or Commonwealth in which the project is located, showing that the piping support system complies with the specified requirements, including all building code and seismic code requirements pertaining to support of piping and other non-structural components. See Section 01 73 23 – Anchorage and Bracing of Non-Structural Components.
4. Table showing the manufacturer's recommended hanger support spacing for PVC, CPVC and FRP pipe for the services listed in Section 40 06 20 – Process Pipe, Valve and Gate Schedules.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The Contractor shall be responsible for the design of all piping support systems unless noted otherwise herein. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility of providing a pipe support design sealed by a Professional Engineer, licensed in the State or Commonwealth in which the project is located. Standard details for pipe supports have been included on the Drawings to define minimum requirements as to the types of Contractor designed pipe supports that will be acceptable.
- B. Where a specific location or type of support is shown on the Drawings, the location and type shall be incorporated in the Contractor's pipe support design.
- C. Where special pipe support fabrications are required, products and execution shall be as specified in Section 05 50 00 – Metal Fabrications and other related and referenced Sections of the Specifications.
- D. Existing piping support systems to support new piping shall only be used if the Contractor can show and demonstrate by submitting supporting calculations that they are adequate for the additional load imposed by the new piping, or if they are strengthened to support the additional load.
- E. Contractor's pipe support design should include, but not be limited to, the following criteria and loads imposed on the piping system:

1. Thrust Loads based on the design pressures as specified in Piping Schedules in Section 40 06 20 – Process Pipe, Valve and Gate Schedules. Pipe support design shall not utilize process equipment for thrust restraint or support of piping loads.
2. Dead loads and live loads per the latest version of ASCE/SEI 7 or the local building code if more stringent. Loads shall include, but not be limited to, the following:
 - a. Weight of pipe
 - b. Weight of pipe contents
 - c. Weight of insulation
 - d. Ice loads (If applicable by location, ice loads per code shall be applied as indicated in the governing building code)
 - e. Seismic loading requirements and conditions as specified in the governing building code and referenced seismic design codes. Refer to Section 01 73 23 – Anchorage and Bracing of Non-Structural Components and the structural code drawing for project specific seismic design criteria. Seismic and sway bracing shall be provided at maximum 10-foot centers.
 - f. Wind loads
3. Loads associated with thermal expansion and contraction of the piping system over the full range of potential temperatures the piping system could experience that should include, but not be limited to, the following:
 - a. Ambient temperature range per local historical weather data (historic high and low obtained from NOAA)
 - b. Process operating temperature range
 - c. Exposure to sunlight where applicable
4. Additional pipe support design considerations shall include the following:
 - a. A minimum safety factor of 2 or as approved by the Engineer, based upon the yield strength of the support material, shall be used for pipe supports, braces, hangers, and guides as well as for beam and column members used in channel-type support systems.
 - b. The horizontal pipe hanger and/or floor support spacing shall be as recommended by the pipe and/or hanger manufacturer but shall not exceed 10 feet on center unless indicated otherwise herein or on the Drawings.

- c. The design, sizing and spacing of anchor bolts, including concrete anchors, shall be based on withstanding shear and pullout loads imposed by loading at each particular support. The minimum anchor bolt size shall be ½ inches in diameter. Refer to Section 05 05 23 – Metal Fastening.

2.02 HANGERS AND SUPPORTS

- A. All piping shall be adequately supported and braced by means of steel hangers and/or supports, concrete piers, supplemental lateral bracing components, pre-fabricated brackets, or otherwise as may be required by the location and forces applied per governing code, including gravity and lateral forces from earthquake and/or wind (if outdoors). Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure. Refer to Standard Detail Drawings.
 1. Metal pipe supports indicated as standard type pipe hangers are designed and detailed for gravity loading only. Resulting lateral loads from wind, earthquake, or other lateral loads per code, or special loading conditions during construction, shall be applied to the pipe in accordance with the governing building code. Supplemental lateral stiffening members (when necessary) shall be provided along pipe or at gravity supports using appropriate supplemental members and connections when required by calculations. The Contractor shall include design calculations and details with all pipe hanger and support submissions for review by the Engineer. The main structure and structural components that will support the pipe hangers and other appurtenant components of the facility have been designed to resist all resulting secondary lateral loading from pipe hangers and other non-structural members for gravity and resulting lateral loads.
- B. Hangers and supports shall conform to the following requirements:
 1. All fabricated metal hangers and supports shall be capable of adjustment after installation. Different types of hangers and supports along a pipe length, including bends, shall be kept to a minimum.
 2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.
 3. Vertical piping shall be properly supported at each floor and between floors by stays or braces to prevent rattling and vibration.

4. Supports and hangers for plastic and FRP piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.
 5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless-steel hangers.
 6. Ferrous pipes that require painting or galvanizing shall be supported by galvanized hangers and supports. Stainless steel piping shall be supported by stainless steel saddles and straps (if required).
 7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.
 8. Plastic piping shall be supported by plastic coated steel hangers and supports.
 9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.
 10. Expansion and adhesive type anchors used for pipe hangers and supports shall be Type 316 stainless steel.
- C. Metallic hangers and supports may be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction. All gravity type hangers and supports shall be restrained laterally to resist seismic loading and other loading as required by the governing code.
- D. Non-metallic support system shall be a heavy-duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

2.03 PROCESS AIR PIPE SUPPORTS

- A. Unless specifically designed and detailed on the Drawings, process air piping shall be supported by slide bearings as manufactured by Fluorocarbon Company, Anaheim, California, Anvil International, Inc., Portsmouth, New Hampshire, or equal.
- B. The slide bearing material shall be 3/32-inch-thick, 25 percent glass-fiber reinforced structural grade Teflon. The bearing material shall withstand at least 1000 psi (compression) at 250°F with a coefficient of friction between 0.05 and 0.08. The performance of bearing and bonding materials shall be unaffected by continual immersion in wastewater containing domestic and industrial waste at a temperature of 210°F.
- C. Non-submerged slide bearing type supports shall be provided with a bearing material covering a 120° arc centered at the bottom of the pipe. The Teflon shall be at least 4 inches wide at the underside of the pipe and 8 inches wide at the top of the support. The Teflon material shall be hot press bonded to 10 ga. stainless steel plates for welding to the bottom of the pipe and securing to the top of the support.
- D. Submerged slide bearing type supports shall be provided with Teflon bonded to the underside of the hold down strap and the top of the pipe such that the sliding surface is formed between two sheets of Teflon. Each surface shall cover a 120° arc centered at the top of the pipe. On the underside of the strap the Teflon bearing shall be hot press bonded directly to the stainless-steel strap or to a 10 ga. stainless steel plate for welding to the strap. At the top of the pipe, the Teflon shall be bonded to a 10 ga. stainless steel plate for welding to the pipe.
- E. Pipe straps shall not tightly bind the pipe but shall provide 1/16-inch clearance over the top 180° of the pipe surface.
- F. Wall bracket supports shall be used where shown for pipe to be installed adjacent to a wall. Where it is not feasible to install hanger supports, adjustable pipe saddle supports may be used with the permission of the Engineer. Concrete pier supports shall be spaced at a maximum distance of 10 feet and shall be at least 12" wider than O.D. of pipe and 10 inches thick unless otherwise shown on the Drawings. Refer to the Standard Detail Drawings.
- G. Small diameter piping (6-inches in diameter or less) shall not be strapped or otherwise secured directly to walls. Suitable wall offset brackets of an approved type shall be used. Anchors shall not be attached using percussion fasteners.
- H. Sliding surfaces shall be protected from accumulation of dirt, grit, or other foreign matter.
- I. Slide bearings shall be capable of adequately supporting the design loads and shall be attached to pipe and supports as specified and recommended by the manufacturer.
- J. The slide bearings shall be installed in the locations shown or indicated on the Drawings, at required elevations, true to orientation and level, assuring that the correct half of each

bearing is in its proper position. The Contractor shall store the bearings to protect them from mechanical damage prior to installation and shall protect the same during and after installation from contamination and damage due to placing of concrete and other materials. The Contractor shall clean the operating surfaces of bearings thoroughly before final assembly.

- K. The Contractor shall note that all pipe support locations are not shown on the Drawings and shall follow the Specifications herein in locating supports. Where deviations and modifications are required, they shall be made only with the permission of the Engineer. A detailed layout of pipe supports and hangers shall be submitted for approval.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Support piping connections to equipment by pipe support and not by the equipment.
- B. Support large or heavy valves, fittings, flow meters and appurtenances independently of the connected piping.
- C. Support no pipe from the pipe above it.
- D. Support piping at changes in direction or in elevation, adjacent to flexible joints, expansion joints, and couplings, and where shown.
- E. The Contractor shall not install piping supports and hangers in equipment access areas or bridge crane runs.
- F. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
- G. Install pipe anchors (fixed supports and/or guides) where shown and/or as may otherwise be required to withstand expansion thrust loads and to direct and control thermal expansion. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that complete details describing location, pipe supports, and hydraulic thrust protection are submitted.

END OF SECTION

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SECTION 40 05 17

COPPER PIPE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 TYPE L COPPER PIPE AND FITTINGS

- A. Type L copper piping shall be seamless, hard drawn and shall conform to ASTM B 88. Solder fittings shall be wrought copper conforming to ANSI B.16.22 or cast brass conforming to ANSI B.16.18 95/5. All exposed copper pipe and fittings shall be Type L.

2.02 TYPE K COPPER PIPE AND FITTINGS

- A. Type K copper piping shall be seamless, soft temper and shall conform to ASTM B 88. Fittings used with this pipe shall be flare or compression type fittings as manufactured by Swagelok, or equal, and shall conform to ANSI B16.26. All buried copper pipe and fittings shall be Type K.

2.03 SOLDER

- A. Solder shall consist of 95 percent tin and 5 percent antimony. Silver solder shall consist of 15 percent silver, 80 percent copper, and 5 percent phosphorous in accordance with ASTM B260-62T. Soldering shall be in conformance with Section 3 of the C.A.B.R.A. Copper Tube Handbook.

2.04 SOFT COPPER TUBING

- A. Soft copper tubing in all sizes, shall conform to the appropriate ASTM Specifications; and fittings used with this tubing shall be compression or flare type, as manufactured by Swagelock, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise

required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.

- B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.
- C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.
- D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections.
- E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.
- F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

END OF SECTION

SECTION 40 05 19
DUCTILE IRON PIPE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A.
- B. Reference Section 40 05 00 – Basic Mechanical Requirements
- C. Reference Section 40 06 20 – Process Pipe, Valve, and Gate Schedules, for pressure rating requirements for specific applications.

1.02 SUBMITTALS

- A. Submittals shall be provided in accordance with Section 01 33 00 – Submittal Procedures.
- B. The Contractor shall submit a certificate from the Manufacturer stating that all linings have been provided in accordance with the specification requirements herein.
- C. The Contractor shall submit spark testing report for all epoxy-lined ductile iron pipe and fittings 36-inches in diameter and larger.

PART 2 – PRODUCT

2.01 DUCTILE IRON PIPE AND FITTINGS

- A. All ductile iron pipe and specials shall be marked with the manufacturer's name or trademark, size, weight, thickness class, the date of manufacture, and the word "Ductile".
- B. Ductile iron pipe of the sizes shown or specified shall conform to AWWA C151/A21.51, Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds.
- C. Ductile iron pipe shall conform to AWWA C150/A21.50 for thickness design and shall be supplied in 18-foot or 20-foot nominal lengths or as required to meet the requirements of the Drawings.
- D. Fittings and specials shall be cast iron or ductile iron and conform to the requirements of AWWA C110/A21.10 and AWWA C153/A21.53.

- E. Minimum Class 53 pipe shall be used for flanged spools.

2.02 PIPE COATINGS

- A. All buried ductile iron pipe and fittings shall have a bituminous coating of standard thickness on the exterior surfaces in accordance with AWWA C151/A21.51.

2.03 PIPE LININGS

- A. All pipe and fittings, with the exception of epoxy and glass lined pipe and sleeves, shall be cement mortar lined. Cement mortar linings shall conform to American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Ductile Iron Pipe and Fittings, AWWA C104/A21.4 and shall be standard thickness. The mortar lining shall be protected with a bituminous seal coat.

B. Epoxy-Lined Pipe

1. Epoxy-lined ductile iron pipe shall be furnished and installed where specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.
2. Epoxy-linings shall be Induron Protecto 401 ceramic epoxy lining, Tnemec Perma-Shield PL Series 431, or equal.
3. The finished lining shall have a minimum dry film thickness of 40 mils, except at the gasket groove and spigot end up to six inches back from the end of the spigot which shall be 6 mils dry film thickness, minimum.
4. Lining application shall be performed in strict accordance with the manufacturer's instructions by an applicator approved by the coating manufacturer and under controlled conditions at the applicator's shop or the pipe manufacturer's plant.

C. Glass-Lined Pipe

1. Glass-lined ductile iron pipe shall be furnished and installed where specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.
2. Glass-lined ductile iron pipe shall be provided in accordance with ASTM B1000.
3. Glass linings shall be Ervite Type SG-14, as manufactured by the Ervite Corporation; Ferroch MEH 32, as manufactured by Water Works Supply and Manufacturing, Co; or equal.
4. The finished lining shall have a dry film thickness between 8 and 12 mils; a hardness between 5 and 6 on the Mohs Scale; a density between 40 and 50 grams per cubic inch (2.5 to 3.0 grams per cubic centimeter) as measured in

accordance with the requirements of ASTM D792; and be capable of withstanding a thermal shock of 350°F without crazing, blistering, or spalling.

5. Glass-lined pipe and fittings that have been lined must be handled from the outside. No forks, chains, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.
6. Cutting of glass lined pipe in the field shall be limited to only one piece per run of pipe, and this shall be for closure purposes only. Spalling of the glass liner shall be no more than 1/8inch back from the cut. Flanges and bolt holes on spool pieces shall be aligned following the glass lining process and shall be sealed and tested prior to shipment in accordance with the manufacturer's recommendation. Warping of flanges and/or pipe may be cause for rejection as determined by the Engineer.

2.04 PIPE JOINTS

- A. Requirements for various types of joints are described in the following paragraphs. **UNLESS OTHERWISE NOTED HEREIN OR ON THE DRAWINGS, ALL EXPOSED DUCTILE IRON PIPING SHALL HAVE FLANGED JOINTS.**
- B. Flanged Joints
 1. Flanged joints and fittings shall have a minimum pressure rating of 250 psi with 125 lb. American Standard flanges.
 2. All flanges and fittings shall conform to the requirements of ASME B16.1.
 3. Flanges shall be ductile iron and shall be of the threaded or screw on type.
 4. The face of the flanges shall be machined after installation of the flange to the pipe. No raised surface shall be allowed on flanges.
 5. Flanged pipe shall conform to the requirements of AWWA C115/A21.15.
 6. Pipe lengths shall be fabricated to meet the requirements of the Drawings.
 7. Gaskets shall be Toroseal by American Cast Iron Pipe Company, Flange-Tyte by US Pipe, or equal. Gaskets shall be full-face, 1/8-inch minimum thickness cloth inserted rubber, red rubber, neoprene, or superior elastomer and shall be compatible with the fluid being conveyed. Gaskets shall have an allowable maximum working pressure and temperature equal to or greater than the service in which it is installed.
 8. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. Bolts used for exposed flanged joints shall be a minimum ASTM A307,

Grade B carbon steel, and be in accordance with AWWA C110/A21.10. Bolts used for flanged joints in submerged applications shall be Type 316 stainless steel and installed with dielectric isolation flange kits and anti-seize. All bolts shall have hexagonal heads and nuts of the same material as the bolt. No washers shall be used.

C. Bell and Spigot Joints

1. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of AWWA C111/A21.11. Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have caston lugs for adequately tying it together.

D. Mechanical Joints

1. Mechanical joints and fittings shall conform to the requirements of AWWA C111/A21.11. Joints shall be made employing a tapered rubber gasket forced into a tapered groove with a ductile iron follower ring. If required by installation conditions, pipe and fittings shall have caston lugs for adequately tying the pipe and fittings together. These shall be in conformance with standard practice and as outlined under the appropriate AWWA Specifications.
2. Bolts for mechanical joints shall be high-strength low-alloy steel tee-head bolts with hexagonal nuts per AWWA C111/A21.11, both coated using a three-layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat.
3. Mechanical coupling joint pipe and fittings shall be split type, shouldered end. Coupling materials shall be malleable iron. Couplings shall have a minimum pressure rating and service equal to that of the connected piping.
4. Gaskets shall be of rubber.
5. After installation, buried couplings shall receive two heavy coats of coal tar epoxy (min. 24 mil thickness) which is compatible with the finish of the couplings.
6. Couplings shall be as manufactured by Victaulic Company of America Style 31, or equal.

E. Restrained Joints

1. Restrained joint pipe shall consist of factory manufactured bolted retainer rings, ductile iron locking segments held in place by rubber retainers, or ductile iron retaining rings that lock over the bell of the joint and are secured to prevent rotation, and factory welded retainer beads or rings on the spigot of the pipe. All

components of the bolted or snap ring assemblies shall be constructed of corrosion-resistant, high strength, low-alloy steel coated using a three-layer system consisting of a metallic base coat, an adhesion coat, and a heat cured fluoropolymer compound containing PTFE as topcoat.

2. Restrained joint pipe shall be Flex-Ring or Lock-Ring type joints as manufactured by American Cast Iron Pipe Company, HP LOK or TR Flex as manufactured by US Pipe, Bolt-Lok or Snap-Lok as manufactured by Griffin Pipe Products, TR Flex or Super Lock as manufactured by Clow Water Systems Co., or approved equal.
3. Restrained fittings for piping systems 16-inches in diameter and greater shall have factory restraint systems identical to the factory restrained joint pipe specified above. All fittings shall be minimum pressure Class 250 unless otherwise specified.
4. Restrained fittings for pipe systems 14-inches in diameter and smaller shall be Mechanical Joint fittings with restraint assemblies such as Stargrip by Star Pipe Systems, Mega Lug by EBAA Iron, ONE LOK by Sigma, Grip Ring by Romac, or approved equal. Restraint assemblies including all hardware shall be painted with two heavy coats of coal tar epoxy after installation. Where threaded-rods are allowed, the rods and tabs shall be designed for the specified restraint system design pressure, shall have lengths less than 10 feet between fittings, and shall be painted with two heavy coats of coal tar epoxy after installation.
5. The manufactured systems for thrust restraint indicated above shall be used where restrained joint ductile iron pipe and fittings are specified or indicated on the drawings. Gripping gaskets are not an acceptable form of restraint. Thrust restraint and harnessing systems such as threaded-rods, friction clamps, retainer glands shall be used only where specifically specified herein, indicated on the drawings or if allowed by the Engineer in isolated applications where conditions warrant and necessitate their use. Concrete thrust blocks may be used in accordance with the schedule indicated on the drawings, if applicable.

2.05 OUTLETS

- A. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, the Contractor shall not use taps and shall refer to Section 40 05 00 – Basic Mechanical Requirements for requirements.

2.06 POLYETHYLENE ENCASEMENT

- A. Wrap all buried ductile iron pipes, valves and fittings with 8 mil polyethylene film per ANSI A21.5/AWWA C-105. Use only tube type for pipe. Complete the wrap prior to placing concrete anchors, collars, supports or thrust blocks. Repair polyethylene if damaged during installation.

2.07 CAST IRON SOIL PIPE

- A. Cast Iron Soil Pipe shall conform to the standards of the Cast Iron Soil Pipe Institute (CISPI) Specification HS-67, and also ANSI Specification A-112.5.2 for Hub & Spigot pipe or A.112.5.1 for Hub & Spigot pipe or A.112.5.1 for No-Hub Pipe. Pipe class shall be "Extra Heavy:(XH).

END OF SECTION

**SECTION 40 05 31
PVC/CPVC PIPE**

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. PVC pipe and fittings shall be manufactured in accordance with ASTM D1785, D1784 and F441, "normal impact" pipe, Schedule 40 or 80 as specified.
- B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.
- C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D1784 and D1785. Fittings shall conform to the following standard specifications:
 - 1. Socket Type: (Schedule 40); ASTM D2466
 - 2. Socket Type: (Schedule 80); ASTM D2467
- D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment except at true (double) union valves. Flange gaskets shall be natural rubber or other material fully compatible with the fluid being conveyed. Where flanged piping is used with chemical systems, the gasket material shall conform to the requirements of the following table. Flange bolts shall be type 316 stainless steel minimum, with higher grade materials used where necessary for fluid (chemical) compatibility.

Chlorine Solution (from gas)	FKM
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- E. Acceptable materials of construction of elastomers for non-chemical service shall be as follows:

Non-Chemical Service	Elastomer Material
Non-Potable Water	EPDM

Non-Chemical Service	Elastomer Material
Process Drain (Gravity)	EPDM
Process Drain (Pressure)	EPDM
Potable Water	EPDM
Reclaimed Water	EPDM
Sample	EPDM
Sump Pump Discharge	EPDM

- F. Solvent cement for socket type joints shall conform to ASTM D2564 for PVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.
- G. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.
1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (± 1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.
 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM D2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.
 4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
 5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.
- H. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (± 1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.
 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM D2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.
 4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
 5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.
- I. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.
1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet ($1\pm$ inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.
 2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM D2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.
 3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.
 4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.
 5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.
- J. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

- K. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D2235.
- L. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D3034 with a maximum SDR of 35. Pipe and fittings shall have bell and spigot ends with O-ring rubber gasketed, compression type joints. Joints shall conform to the requirements of ASTM Specification D3212. Reruns of reclaimed materials shall not be accepted. Unless indicated otherwise, PVC wall pipes shall be provided for all piping passing through exterior walls. Wall pipes shall have a water stop solvent-welded to the pipe. Each wall pipe shall be of the same class and type as the piping to which it is joined.
- M. Perforated and closed drainage pipe and fittings shall be rigid PVC pipe, Schedule 40 unless otherwise shown or specified with solvent welded type joints, or approved equal. Pipe shall be slotted or have two rows of 1/4-inch diameter holes spaced 4-inches apart along the circumference of the pipe. Longitudinal spacing of holes shall be 5-inches maximum.

2.02 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

- A. CPVC shall be manufactured in accordance with ASTM D1785, D1784 and F441, "normal impact" pipe, Schedule 40 or 80 as specified.
- B. Fittings used with this pipe shall be socket type or flanged type as specified herein or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.
- C. CPVC pipe shall be Type 4, Grade 1, Schedule 80, conforming to ASTM D1784 and ASTM F441. CPVC fittings shall be socket type conforming to ASTM F439.
- D. Solvent cement for socket type joints shall conform to ASTM F493 for CPVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

2.03 REINFORCED THERMOPLASTIC HOSE AND FITTINGS

- A. Reinforced thermoplastic hose shall be clear type, reinforced with polyester yarn. Hose material shall be PVC, EVA (Ethyl Vinyl Acetate), or Low-Density Polyethylene, depending on the application, as indicated in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Hose shall be rated for the following working pressures:

Internal Diameter	Minimum Working Pressure (at 68°F)
1/2"	200 psi (75 psi at 150°F)
1"	125 psi (50 psi at 150°F)

Internal Diameter	Minimum Working Pressure (at 68°F)
1-1/2"	100 psi
2"	75 psi

- B. Hoses shall be continuous from the source to the discharge unless shown otherwise on the drawings. Splices shall not be allowed unless approved in writing by the Engineer. If allowed, splices shall occur only in handholes or manholes. Connections and splices, if allowed, shall be barb and clamp type using materials that are compatible with the chemical being conveyed.
- C.
- C. Reinforced thermoplastic hose shall be a manufactured product of Parker Nexgen or equal.
- D. Wetted materials shall be completely resistant to corrosion by the specified chemicals. Hose manufacturer shall guarantee that the hose is suitable for the intended service.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.
- B. Plastic piping shall not be installed when the temperature is less than 60 degrees F except as otherwise recommended by the manufacturer and approved by the Engineer.

END OF SECTION

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SECTION 40 05 51
VALVES, GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.
- B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."
- C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.
- D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

- A. The following items shall be submitted in accordance with, or in addition to the submittal requirements specified in Section 01 33 00 – Submittal Procedures and Section 46 00 00 – Equipment General Provisions:
 - 1. Performance tests shall be conducted in accordance with the latest revision of AWWA C500.
 - 2. Shop Drawings conforming to the requirements of Section 01 33 00 – Submittal Procedures, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full

compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

3. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the equipment named below to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures in accordance with the following schedule:

Item	Valve/Operator Type	Minimum On-Site Time Requirements
1	Automatic Control Check Valve	One (1) 8-hour day
2	Surge Anticipators	One (1) 8-hour day
3	Motor Operated Modulating Valves	One (1) 8-hour day
4	Motor Operated Open-Close Valves (required only if manufacturer is other than for Item 3 above)	One (1) 8-hour day
5	Pneumatic Hydraulic Cylinder Operated Valves	One (1) 8-hour day

- B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day they are at the project.
- C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.

- D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 – PRODUCTS

2.01 FLOW INDICATORS

- A. Flow indicators shall be the Akron ball-type as manufactured by Brooks Instrument Co., Fischer and Porter, or equal, and shall have bronze bodies, glass dome, and plastic ball.

2.02 CORPORATION STOPS

- A. Corporation stops shall be of bronze with tapered male iron pipe threads on inlets and outlets. Terminal outlets shall have screwed bronze hex head dust plugs or caps. Unions shall be used on all corporation stop outlets with connecting piping. Corporation stops shall have a minimum working pressure rating of 250 psi and shall be as manufactured by Mueller Co., Hays Mfg. Div. of Zurn Industries, or equal.

2.03 FLOOR BOXES

- A. Floor boxes shall be provided for all nut operated or floor accessed valves. Floor boxes shall be of the adjustable, sliding type, cast iron, suitable to withstand heavy traffic, as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., or equal. The covers shall be marked with appropriate designations of piping contents (i.e.: water, sewer) and bases shall be the round type. All nut operated valves in this Section shall be clearly identified by stainless steel or laminated plastic identification tags. The tags shall be permanently affixed to the inside of the floor boxes, under grating, etc. and shall bear the embossed letters which clearly identify each valve by its appropriate designation.
- B. Two (2) valve operating wrenches shall be supplied in 4-foot lengths with tee handles for each size nut supplied. Valve wrenches shall be Model No. F-2520 as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Figure No. 122, or equal.

2.04 VALVE BOXES

- A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.
- B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.

- C. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: WATER). Boxes shall be as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Charlotte Pipe and Foundry Company, or equal.

2.05 STRAINERS

- A. Y-Strainers shall be Y-pattern cast iron body, flanged or screwed ends with stainless steel or Monel, 20 mesh strainers. Strainers shall be 200 psi, cold-water service strainers, as manufactured by WATTS, Crane Co., Zurn, or equal.
- B. Caustic service Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.
- C. Stainless steel Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.
- D. PVC and CPVC y-strainers shall be provided in PVC and CPVC piping and as shown on the Drawings. Strainer shall be provided with PVC or CPVC body and end cap, EPDM or Viton seal as required for the chemical service, and 20 mesh screen. Temperature rating shall be 30°F to 140°F, and pressure rating shall be 150 psi @ 70°F, non-shock. PVC and CPVC y-Strainers shall be as manufactured by Asahi/America, Hayward, or equal.
- E. Manually cleaned strainers shall be the duplex basket tapered plug type.
 - 1. Strainers 3-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150-pound standard.
 - 2. Strainers less than 3-inches in diameter shall have screwed end connectors, unless otherwise shown on the Drawings.
 - 3. Strainers shall be constructed with an ASTM A48, Class 30 cast iron body, ductile iron trim, removable 0.045-inch staggered hole perforation, 304 stainless steel filter baskets and gauges on the inlet and outlet.
 - 4. All strainers shall be suitable for 125 psi service.
 - 5. Switching flow from one basket to the other shall be accomplished by moving the handle through a 180° arc. The switching operation shall not stop flow through the strainer and shall provide for on-line removal of either basket with the other basket functional. The plug shall be automatically positioned with integral stops and shall be easily lifted and reseated under pressure.

6. The strainer shall be designed to minimize the possibility of material bypassing the plug while being rotated and to prevent debris from building up under the plug. The strainer covers shall be designed for quick opening with swing away yoke.
 7. Each basket compartment shall have a side drain outlet.
 8. All strainers shall be provided with support legs.
 9. Duplex basket strainers shall be similar to the Model 53BTX as manufactured by Hayward, or equal.
- F. PVC and CPVC simplex basket strainers shall be provided in PVC and CPVC piping as shown on the Drawings. 1/2"-4" strainers shall be one-piece molded body with (3) ports to facilitate straight-thru flow pattern or u-shape flow pattern as required. Connections shall be true union type to ease installation/future maintenance. The cover, vent plug, and drain plug shall all be hand-removable, requiring no tools. EPDM or Viton seals shall be used as required for chemical service, and internal baskets shall be 1/32" perforation (20-mesh) for 1/2"-1" sizes, and 1/8" perforation for 1-1/2"-8" sizes. 6" and 8" strainers shall be fabricated construction and shall contain flanged connections as standard. The pressure rating for 1/2"-8" sizes shall be 150 psi @ 70°F, non-shock. Strainers shall be manufactured by Hayward Industrial Products, or equal.

2.06 QUICK DISCONNECT COUPLINGS

- A. Quick disconnect type coupling for compressed/service air shall be provided where indicated on the Drawings. Coupling shall provide for instantaneous shutoff in socket end when lines are disconnected. Couplings shall be constructed of 316 stainless steel with a BUNA-N O-ring and integral safety lock. Couplings shall comply with Military Specification 4109 (interchangeable with standard plug of the same size).

2.07 BACKFLOW PREVENTERS

- A. Backflow preventer shall be the size shown on the Drawings and shall be of the double check valve principle. Backflow preventer installation shall include isolation valves and four test cocks, furnished as an assembly. For backflow preventers less than 2-1/2", the installation assembly also shall include a strainer. Isolation valves for backflow preventers shall be ball valves, except for size 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The backflow preventer shall be a WATTS 709, or equal.
- B. Reduced Pressure Backflow Preventer shall be of the size shown on the Drawings and shall be of the reduced pressure principle type in accordance with AWWA Standards C510 and C511, with two (2) independent operating spring loaded check valves and one (1) spring loaded, diaphragm actuated, differential pressure relief valve shall be installed between the check valves. Backflow preventer shall be bronze body construction, with

EPT rubber discs and Buna-N and nylon diaphragm. Screws and springs shall be of stainless steel. End connections shall be screwed, unless otherwise specified or shown on the Drawings. Reduced pressure backflow preventer installations shall include isolation valves and four test cocks, furnished as an assembly. For reduced pressure backflow preventers less than 2-1/2" the installation assembly also shall include a strainer. Isolation valves for reduced pressure backflow preventers shall be ball valves, except for sizes 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The reduced pressure backflow preventer shall be as manufactured by Beeco Division, Hersey Products Inc., Aergap Model 6CM, WATTS 909, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.
- B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.
- C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.
- D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.
- E. Valve boxes shall be set plumb and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.02 SHOP AND FIELD TESTING

- A. Shop and field testing of valves shall be as follows:
1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.
 2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.
 3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.
 4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.
 5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
 6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments

required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.

7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system under normal operating conditions and during simulated power failures shall be checked.
8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 BUTTERFLY VALVES (WATER SERVICE)

- A. Butterfly valves (water service) shall be of the rubber seated, tight closing type conforming to the latest revision of AWWA C504. The manufacturer shall have a minimum of 5 years of experience in manufacturing butterfly valves of the sizes required in accordance with AWWA C504. All butterfly valves shall be the product of one manufacturer. Butterfly valves shall be as manufactured by Pratt, Mueller Co., DeZurik, GA Industries, or equal. Each valve shall be performance and leak tested as specified in AWWA C504 revised as follows: In addition to the testing requirements of AWWA C504, each butterfly valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.
- B. Butterfly valves shall be Class 150B, unless otherwise indicated in the valve schedules, and of the short body design with mechanical joint or flanged ends, as shown on the Drawings.
- C. Valve bodies shall be epoxy coated cast iron conforming to ASTM A-126, Grade B, ASTM A-48, Class 40 or Ductile Iron ASTM A536, Grade 65-45-12. Where required to meet design operating conditions, valve bodies shall be manufactured of higher strength materials. Valve bodies shall have integral hubs for housing shaft bearings and seals.
- D. Butterfly valves shall be of the concentric or eccentric shaft types. Valve discs shall be constructed of epoxy coated ductile iron, ASTM A536, Grade 65-45-12. Discs shall provide a full 360 degree seating surface with no external ribs transverse to flow, and shall comply with the latest revision of AWWA C504. The valve manufacturer shall furnish Shop Drawings which include end clearance dimensions when the disc is in the fully open position.
- E. The resilient valve seat shall be synthetic rubber designed to seat against a pressure differential of 150 psi on either side of the valve, unless otherwise indicated. The resilient seat shall be mechanically attached to the valve disc or valve body. Any required seat attachment hardware shall be stainless steel. The resilient seat shall be capable of being adjusted or replaced in the field without moving the valve disc along the shaft axis or

removing the valve from the line. The mating seat surface shall be stainless steel or monel.

1. The seats shall be factory tested as per AWWA C504 at a test pressure of 150 psig, unless otherwise indicated, and post adjusted for differential pressures indicated herein.
- F. Valve shafts shall be one-piece or two-piece units of stainless steel construction suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve disc by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material.
- G. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of teflon or heavy-duty bronze. The valve assembly shall be furnished with a factory set two-way thrust bearing designed to center the valve disc in the valve seat at all times. End cover bolts shall be of stainless steel construction.
- H. The shaft seal shall be either the bronze cartridge type with at least two O-rings, monolithic V-Type, U-Cup Type, or pull down packing type. If monolithic V-Type, U-Cup Type, or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Butterfly valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator. For buried valves with pull down packing the packing gland cover assembly shall be heavy duty, soil and water resistant. Stuffing boxes for pull down packing shall have a depth sufficient to accept at least four rings of self-compensating type packing specifically selected for the operating pressures to be encountered. Stuffing box bolts, studs and nuts shall be stainless steel.
- I. The "O" ring type shaft seal shall be contained in a removable bronze cartridge. The bronze cartridge shall be manufactured from ASTM B505 copper alloy UNS #C93200 and shall meet the requirements of AWWA C504 for bronze, Grade E. The "O" ring material shall be nitrile, Buna-N rubber, as intended for use with potable water or wastewater and per ASTM D-2000 with a hardness of 70 Shore A Durometer.
- J. Manual operators for butterfly valves 18-inches in diameter or larger shall be the worm gear type conforming to AWWA C504. Manual operators for butterfly valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops, shall be sized according to Table IV for Class 150B, and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under the differential pressure of 150 psi and maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule.

- K. The manufacturer shall certify that the butterfly valves are capable of operating in continuous duty service under these pressures and flow conditions.
- L. Each valve shall be hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.
- M. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

PART 3 – EXECUTION (NOT USED)

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**SECTION 40 05 68.13
PVC AND CPVC VALVES**

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

- A. Valves shall be constructed of materials suitable for the intended service. PVC valves shall be provided in PVC piping and CPVC valves shall be provided in CPVC piping.
- B. PVC valve bodies shall be constructed of PVC which shall meet or exceed the requirements of cell classification 12454 according to ASTM D1784. CVPC valve bodies shall be constructed of CPVC which shall meet or exceed the requirements of cell classification 23447 according to ASTM D1784.
- C. Materials of construction of other valve components shall be as specified below for the particular type of valve.
- D. Acceptable materials of construction of elastomers for chemical service shall be as follows:

Chemical Service	Elastomer Material
Chlorine Solution (from gas)	FKM

- E. Acceptable materials of construction of elastomers for non-chemical service shall be as follows:

Non-Chemical Service	Elastomer Material
Non-Potable Water	EPDM
Process Drain (Gravity)	EPDM
Process Drain (Pressure)	EPDM
Potable Water	EPDM
Reclaimed Water	EPDM, FKM

Non-Chemical Service	Elastomer Material
Sample	EPDM
Sump Pump Discharge	EPDM

- F. All flanged valves shall be flat face flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb. flanges.

2.02 PVC/CPVC BALL VALVES (BLV-P/BLV-C)

- A. Ball valves shall be true union design with flanged, socket, or threaded ends as required and as specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. All valves shall be full-port design and allow for bi-directional flow. Valve stems shall contain double o-ring seals. Valves shall have removable handles and integrally molded mounting features for actuator installation. Ball valves shall be rated for a minimum pressure of 150 psi at 70°F.
- B. Valve bodies, stems, balls, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. Ball seats shall be made of PTFE, and o-ring seals shall be as specified in 2.01 D and 2.01 E.
- C. Ball valves shall be manufactured by Asahi/America, Nibco/Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.
- D. Ball valves for sodium hypochlorite service shall be vented, with a single hole factory-drilled into the ball to vent in the upstream direction when the ball is in the closed position. Valves shall be color coded or marked to indicate vented ball design.
- E. Where valves are installed in piping to be insulated and jacketed, stem extensions shall be furnished and installed such that the valve can be operated without any interference with these components.

2.03 PVC/CPVC SWING CHECK VALVES (CV-PS/CV-CS)

- A. Swing check valves shall be single-disc design with pivoting swing arm/disc clapper assembly and flanged ends. Valves shall be full flow, gravity operated, and suitable for either horizontal or vertical applications. Valves shall be capable of top entry to facilitate cleaning and repair without removal from the line. Swing check valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies, bonnets, swing arms, and discs shall be constructed of PVC or CPVC as specified in 2.01 B. O-ring seals and shutters shall be as specified in 2.01 D and 2.01 E.
- C. Swing check valves shall be manufactured by Asahi/America, IPEX, Hayward Flow Control, or equal.

2.04 PVC/CPVC BALL AND DIAPHRAGM CHECK VALVES (DCV-P/DCV-C)

- A. Ball and diaphragm check valves shall be true union design with flanged, socket, or threaded ends as required and as specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Primary seat shall be square-cut design to ensure proper seating. Valves shall be suitable for either horizontal or vertical applications. Ball and diaphragm check valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies, balls or diaphragms, end connectors, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. O-ring seals shall be as specified in 2.01 D and 2.01 E.
- C. Ball and diaphragm check valves shall be manufactured by Asahi/America, Nibco/Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.05 PVC/CPVC DIAPHRAGM VALVES (DV-P/DV-C)

- A. Diaphragm valves shall be weir-type design with multi-turn handwheel for throttling applications. Diaphragm valves shall have flanged, socket, or threaded ends as specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Valves shall have a position indicator and adjustable travel stop. Diaphragm valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies, bonnets, end connectors, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. Valve diaphragms and o-rings shall be as specified in 2.01 D and 2.01 E. PVDF vapor barrier shall be provided for PTFE diaphragms.
- C. Diaphragm valves shall be manufactured by Asahi/America, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.06 PVC/CPVC BUTTERFLY VALVES (BFV-P/BFV-CP)

- A. Butterfly valves shall be of flanged design. Valves 6” and smaller shall have lever handles, and larger valve shall have gear operators. Valves shall have the ability to mount actuators. Face seals shall completely isolate the valve body from process flow and function as a flange gasket on both sides of the valve. Butterfly valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies and discs shall be constructed of PVC or CPVC as specified in 2.01 B. Valve shafts shall be made of 316 stainless steel. Valve disc liners and o-ring seals shall be as specified in 2.01 D and 2.01 E.
- C. Butterfly valves shall be as manufactured by Asahi/America, Nibco/Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.07 PVC/CPVC NEEDLE VALVES (NV-P/NV-C)

- A. Needle valves shall be provided for accurate flow control applications. Valves shall have integrated stem/seat design and have fine pitch stem threads for precise adjustment. Valve ends shall be flanged, socket, or threaded as specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Needle valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies shall be PVC as specified in 2.01 B, seats shall be PTFE, and o-ring seals shall be as specified in 2.01 D and 2.01 E.
- C. Needle valves shall be as manufactured by Nibco/Chemtrol, Hayward Flow Control, or equal.

2.08 PVC/CPVC GLOBE VALVES (GLV-P/GLV-C)

- A. Globe valves shall be provided for flow regulation applications. Valves shall be of union bonnet or outside stem and yolk design. Valve ends shall be flanged, socket, or threaded as specified in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Globe valves shall be pressure rated for 150 psi at 70°F.
- B. Valve bodies and discs shall be PVC as specified in 2.01 B, and seals shall be as specified in 2.01 D and 2.01 E.
- C. Globe valves shall be as manufactured by Asahi/America, or equal.

2.09 PVC/CPVC DEGASSING VALVES (DGS-P/DGS-C)

- A. Degassing valves shall be provided to continuously vent gases for a liquid-carrying pipeline or vessel. The float-operated valve will open when liquid level falls (indicating the presence of gas) and close when the gas has been evacuated as the liquid level rises. The valve is to automatically vent gas collected over liquid to a pressure of 100 PSI. The specific gravity of the liquid shall not be less than 0.9. Degassing valves shall be installed vertically, at high points in the piping system where gases collect.
- B. The Valve body shall be PVC or CPVC. The internal float shall be constructed of Natural Polypropylene. Seals shall be EPDM or Viton, as specified above. There shall be a ½” Female NPT process connection and 1/8” Female NPT vent port.
- C. Degassing Valves shall be as manufactured by Plastomatic, or equal.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 05 97
PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping.
- B. In addition to the legends specified herein, the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.
- C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01 33 00 – Submittal Procedures and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.
- D. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 PIPING BAND

- A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefinished metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

2.02 PIPING IDENTIFICATION LEGEND

- A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

Diameter of Pipe or Pipe Covering	Height of Lettering
3/4 to 1-1/4 inches	1/2-inches
1-1/2 to 2-inches	3/4-inches
2-1/2 to 6-inches	1-1/4-inches
8 to 10-inches	2-1/2-inches
Over 10-inches	3-1/2-inches

- B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4-inch in diameter, the Contractor shall furnish and attach approved color-coded tags where instructed.
- C. The colors referenced in the legend are as manufactured by KOP-COAT. They are used for convenience only.
- D. Piping and Equipment Identification

<i>SERVICE</i>	<i>LEGEND</i>	<i>BASE</i>
<i>CHLORINE SOLUTION</i>	<i>CHLORINE SOLUTION</i>	<i>NOT PAINTED</i>
<i>POTABLE COLD WATER</i>	<i>POTABLE WATER</i>	<i>LIGHT BLUE</i>
<i>POTABLE HOT WATER</i>	<i>POTABLE WATERHOT</i>	<i>LIGHT BLUE</i>
<i>NONPOTABLE WATER</i>	<i>NONPOTABLE WATER</i>	<i>LIGHT GREEN</i>

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 06 20

PROCESS PIPE, VALVE, AND GATE SCHEDULES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 - Basic Mechanical Requirements.

1.02 PIPING SCHEDULES

- A. Piping requirements for this Section are outlined on the Drawings and in the Piping Schedules. In the absence of a specified test pressure, pipe shall be tested at the greater of: 1) 150 percent of working pressure as determined by the Engineer or 2) 10 psig, unless the Schedule indicates no test is required.
- B. If the pipe material is not shown on the Piping Schedule or otherwise specified, the following materials shall be used.

PIPE SIZE	MATERIAL	TYPE OF JOINT	CLASS/DESIGN	TEST PRESSURE
4-IN AND LARGER	DIP	FLANGED (EXPOSED)	CLASS 53	(1)
		RESTRAINED (BURIED)	PRESSURE CLASS 350	
LESS THAN 4-IN	PVC/CPVC (2)	SOCKET	SCH 80	(1)

(1) Test at 150 percent of working pressure or 10 psi, whichever is greater.
(2) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.

1.03 VALVE SCHEDULES

- A. All valves shall be tagged by the manufacturer according to the control valve designations listed in this Section.
- B. Valves not listed in this Section shall be manually operated, unless otherwise shown on the Drawings.

1.04 GATE SCHEDULES

- A. Gates shall be tagged by the manufacturer according to locations listed in this Section.

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WATER TREATMENT PLANT PIPING SCHEDULE											
PIPE DESIGNATIONS		MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI) ¹			
			TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE ²	WORKING	SURGE	RESTRAINT	FIELD TEST
FE	FILTERED EFFLUENT	DIP	RESTRAINED	PRESSURE CLASS XXX	FLANGED	CLASS 53	NO	25	30	30	50
		CARBON STEEL	WELDED	SECTION 40 05 24.23	WELDED/ FLANGED ⁴	SECTION 40 05 24.23	NO				
FW	FINISHED WATER	DIP	RESTRAINED	PRESSURE CLASS XXX	FLANGED	CLASS 53	NO	100	150	150	150
		CARBON STEEL	WELDED	SECTION 40 05 24.23	WELDED/ FLANGED ⁴	SECTION 40 05 24.23	NO				
PW	POTABLE WATER	< 4" PVC / CPVC ³	SOCKET	SCH 80	SOCKET/ FLANGED	SCH 80	NO	50	75	75	100
		< 4" COPPER	SOLDERED	TYPE K	SOLDERED	TYPE L	NO				
		> = 4" DIP	RESTRAINED	PRESSURE CLASS XXX	FLANGED	CLASS 53	NO				
SA	SAMPLE	< 4" CPVC ³	SOCKET	SCH 80	SOCKET/ FLANGED	SCH 80	YES	20	30	30	40
V	VENT	< 4" PVC / CPVC ³	SOCKET	SCH 80	SOCKET/ FLANGED	SCH 80	N/A	0	0	0	0
		> = 4" DIP	RESTRAINED	PRESSURE CLASS XXX	FLANGED	CLASS 53	N/A				

1) Surge pressure is the maximum pressure in the system during a surge event. Restraint pressure shall be used to determine pipe joint design and if required, the size, number, material, and dimensions of tabs and threaded-rods and thrust blocking for thrust restraint of piping and piping system components specified.

2) Provide heat tracing and insulation as specified in Section 40 41 13 on all exposed outdoor piping indicated.

3) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.

4) Flanges shall be provided as shown on the drawings or as approved by the Engineer.

CHEMICAL PIPING SCHEDULE										
PIPE DESIGNATIONS		MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI) ¹		
			TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE ²	WORKING	RESTRAINT	FIELD TEST
CLG	CHLORINE GAS VACUUM	PVC / CPVC ³	SOCKET	SCH 80	SOCKET/ FLANGED	SCH 80	N/A	50	100	100

1) Surge pressure is the maximum pressure in the system during a surge event. Restraint pressure shall be used to determine pipe joint design and if required, the size, number, material, and dimensions of tabs and threaded-rods and thrust blocking for thrust restraint of piping and piping system components specified.

2) Provide heat tracing and insulation as specified in Section 40 41 13 on all exposed outdoor piping indicated.

3) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.

4) Flanges shall be provided as shown on the drawings or as approved by the Engineer.

SECTION 40 41 13
HEAT TRACING SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install heat tracing and insulation systems as shown and required by notes in the drawings or as required by the Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. All heat tracing components shall be supplied by the same manufacturer. The heat tracing and insulation system shall include but shall not be limited to self-regulating heater cables, grommet end termination kits, power connection kits, splice kits, NEMA 4X enclosed thermostats, piping insulation and jacket and installation tape. The intent of this specification is for the contractor to supply all appurtenances needed for a complete and fully operational system at each location that a heat tracing system is required. The heat tracing system supplier shall be completely responsible for the design of the system such that the entire system meets all aspects of this specification and the system functions in the environment where it will be installed. All parameters of the system shall be sized and as recommended by the supplier.
- B. The heat tracing system(s) shall be provided in accordance with the requirements of Section 40 05 00 – Basic Mechanical Requirements.
- C. Piping insulation and jacket shall be supplied with all heat traced piping and shall be in conformance with Section 40 42 13 – Insulation. The thickness of the insulation shall be as stipulated in this specification.
- D. All air release valve piping that will remain constantly wet and that is installed outdoors shall be heat traced. All pressure gauge piping installed outdoors shall be heat traced and insulated.
- E. The minimum design ambient temperature for the heat tracing system design shall be - 1040°F. .
- F. All the components of the heat tracing system shall be individually Underwriters Laboratory (UL) listed. The system as supplied shall conform to all applicable parts of the following:
 - 1. National Fire Protection Association (NFPA)
 - 2. National Electric Code (NEC)
 - 3. Local and State/Commonwealth Building Codes

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Heat tracing system conductors and insulation for METAL piping shall be supplied in conformance with the following table:

Heat Tracing Conductors and Insulation for Metal Piping

Pipe Size (in)	Insulation Thickness (in)	Cable Heat Rating Watts per Foot	
		Design Air Temperature -10°F	Design Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5
1-1/2	1	3	5
2	1	3	5
2-1/2	1	3	5
3	1-1/2	3	5
4	1-1/2	5	8
6	2	5	8
8	2	5	8
10	2	8	10(1)
12	2	8	10(1)

- 1) Two conductors shall be provided and shall be placed on top of and under the pipe.

- B. Heat tracing system conductors and insulation for NONMETALLIC.

- C. Piping shall be supplied in conformance with the following table:

Heat Tracing Conductors and Insulation for Nonmetallic Piping

Pipe Size (in)	Insulation Thickness (in)	Cable Heat Rating Watts per Foot	
		Ambient Air Temperature -10°F	Ambient Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5

Pipe Size (in)	Insulation Thickness (in)	Cable Heat Rating Watts per Foot	
		Ambient Air Temperature -10°F	Ambient Air Temperature -40°F
1-1/2	1	3	5
2	1	3	5
2-1/2	1	5	8
3	1-1/2	3	8
4	1-1/2	5	8
6	2	5	8
8	2	8	10
10	2	8(2)	(1)
12	2	8(2)	(1)

- 1) Consult the heat tracing system manufacturer for the cable rating and the number of passes for each pipe.
- 2) Two conductors shall be provided and shall be placed on top of and under the pipe.

1.03 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01 33 00 – Submittal Procedures:
1. Submittal data on all components of the heat trace system and any other data recommended by the manufacturer
 2. Installation and maintenance instructions
 3. List of replacement parts for the entire system in table format
 4. Bill of materials list of the system as supplied in table format

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Each heat trace system shall be supplied by Thermon Manufacturing Company, Raychem Corporation or Chromalox. All system components shall be supplied by a single manufacturer.

2.02 MATERIALS

- A. The self-regulating heater cable assembly shall consist of two parallel copper bus wires, minimum size 16 AWG, connected through a semi-conductive heating matrix. This heating element shall be covered with a cross-linked polyolefin insulation jacket. This insulation shall be covered by a tinned copper braid and then covered with a fluoropolymer insulating jacket. All heat cables shall be rated for 120 volt supply voltage.
- B. Each heat tracing circuit shall be supplied with a power connection and end seal kit. Each end seal kit shall include a lighted end termination kit Chromalox model UESL or equal. It shall be the Contractor's responsibility to make sure that no circuit in the system be longer than as recommended by the heat tracing system manufacturer.
- C. All terminations, splices, junctions and tee's in the circuit shall be made using manufacturer recommended and supplied kits. Junction boxes shall be provided where required for access to all circuit appurtenances.
- D. Flexible heater elements shall be provided where indicated on the Drawings to protect pumps & other equipment. The flexible heater shall be 3 inches wide by 40 inches long and shall consist of a heater element encapsulated in silicone rubber. The silicone rubber shall be rated for a temperature range of -80°F to 390°F. The flexible heater shall be designed with eyelets in the ends and edges as required for mounting on the pump using manufacturer supplied silicone straps. The flexible heater shall be rated for 120 Vac and 600 watts of heat output. The flexible heater shall be supplied with a preset thermostat which will energize the flexible heater when the ambient temperature reaches 40°F and shut down the heater when the ambient temperature reaches 50°F. The flexible heater shall be model SL-N as manufactured by Chromalox or equal.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

- A. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat for each circuit shall be an adjustable ambient sensing thermostat designed for controlling the heating cable to provide freeze protection of pipes. The thermostat shall have an adjustable range of 15°F to 140°F. The enclosure for the thermostat shall be NEMA 4X. The Thermostat shall be rated to match the voltage of the heating cable and shall have a switch rating of 20 amps (minimum). Thermostat shall be suitable for use in

Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where thermostat is shown to be installed in hazardous locations. SPARE PARTS

- B. Spare parts shall be provided in accordance with Section 46 00 00 – Equipment General Provisions and shall include the following:
 - 1. 25 ft. of self-regulating cable for each cable wattage provided for the system(s)
 - 2. One (1) spare ambient thermostat controller for each heat tracing system
 - 3. Two (2) each of the following: cable termination kits, cable splice kits and cable tee kits

PART 3 – EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 46 00 00 – Equipment General Provisions and shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	0	0
Startup and Training	1	1

3.02 INSTALLATION

- A. The installation of all heat tracing and insulation components shall conform to all instructions and requirements recommended by the heat tracing system manufacturer. All installation and terminations shall conform to the National Electric Code.
- B. All piping shall be pressure tested prior to installation of any heat tracing or insulation components. Thermal insulation shall only be installed when all heat tracing components are in place and satisfactorily tested as indicated herein. Once tested, the insulation shall be installed immediately to prevent damage to the heat tracing system components.
- C. No insulation shall be installed using staples. Insulation jackets shall be installed as recommended by the insulation system supplier such that no damage is done to the heat tracing system components.

- D. The installation of heat tracing cable on nonmetallic pipe shall be done in strict conformance with the heat tracing manufacturer's recommendations. Requirements shall include heat shielding tape or wrap as recommended by the heat tracing manufacturer
- E. Contractor shall install weather proofing for all outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8-inch gap. Place preformed 2-inch butt strap with sealant over the seam and secure with 1/2-inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings
- F. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used
- G. A label shall be installed on the piping insulation jacket every 15 feet and readily visible from ground level: ELECTRIC HEAT TRACING: CAUTION

3.03 FIELD TESTING

- A. All heating cable shall be tested using a megohmmeter (megger) between the heating cable bus wires and the metallic ground braid. A 2,500 VDC megger test is required and the minimum acceptable resistance value shall be 20 megaohms regardless of the circuit length. Any cables found to be less than this value shall be replaced at no additional cost to the Owner. The megger tests shall be performed as follows:
 - 1. After installation of the cable and all fabrication kits but prior to installing any of the insulation system components.
 - 2. After installation of the insulation system components but prior to energizing the cables.
 - 3. All test reading for each megger test shall be recorded by the installer and submitted with the maintenance instructions.

END OF SECTION

SECTION 40 42 13

INSULATION

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install insulation as shown on the Drawings or otherwise specified. Insulation shall not be installed until piping has been field tested and approved by the Owner. The Contractor shall protect the insulation from moisture at all times.
- B. Reference Section 46 00 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 INSULATED PROCESS/CHEMICAL PIPING

- A. Fiberglass insulation shall be Owens Corning Fiberglass Corp., Fiberglass 25ASJ/SSC; Certain Teed Products Corporation, Certain Teed snap-on ASJ/SSL; or equal. Insulation shall be heavy density sectional pipe insulation with vapor barrier and self-sealing lap. Minimum density insulation density shall be 6 pounds per cubic foot. Contractor shall use manufacturer's recommended adhesives and tape for jointing material. Fittings shall be molded fiberglass. Minimum insulation thickness shall be 1-1/2 inches for 4" diameter pipe and larger, and 1 inch for smaller pipe. Insulation thickness for heat traced pipe is specified in Section 40 41 13 – Heat Tracing Systems.
- B. Weatherproof insulation jacket for process piping shall be Certain Teed Products Corporation; Childers Products Company, Lock On and Slip On; or equal. Jacket shall be smooth embossed aluminum metal jacket with minimum thickness 0.016 inches thick for interior installations and at least 0.031 inches thick for exterior installations. Fastening shall use preformed "2"-lock seam with 2 inch butt strap with sealant. Bonds shall be 1/2 inch aluminum with wing seals. Fittings shall be prefabricated 0.016/0.031 inches thickness aluminum.
 - 1. Contractor shall install weather proofing for outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings.
- C. Insulation fitting covers and jacket for chemical piping shall be Zeston 2000 PVC by Manville, or equal. Fitting covers shall fit snugly over fittings, including all elbows and valves, etc. Jacketing shall be high-impact UV-resistant covering for insulated piping and

shall match fitting covers. Fitting covers and jackets shall be white and suitable for painting. PVC jacketing shall be 30 mil thick and shall be factory curled to fit snugly. Fitting covers and jacketing shall be secured with tacks.

- D. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used.

2.02 INSULATED AIR PIPING

- A. Fiberglass insulation shall be provided for exposed exterior blower discharge piping as shown on the Drawings and as specified herein. Insulation shall be a roll of semi-rigid fiberglass board insulation. The fibrous insulation is adhered to the ASJ jacket with the end grain of the insulation perpendicular to the jacket surface. Each section of insulation may be secured on the longitudinal seam by using staples and mastic or vapor barrier ASJ pressure sensitive tape. Adjacent sections shall be butted together and sealed with vapor barrier ASJ tape. The insulation shall be 2-1/2 inches thick with a fiberglass density of at least 3 pounds per cubic foot.
- B. Insulation for fittings and flanges shall be mitered segments of nominal 6 pounds per cubic foot density fiberglass pipe covering. Cover with a coat of insulating cement then embed a 20 x 20 weave white glass reinforcing cloth between two 1/16 inch coats of Benjamin Foster 30-36. The glass cloth and second coat shall overlap adjacent covering by two inches. Insulation shall be fiberglass pipe wrap as manufactured by Owens-Corning, Johns Mansfield, or equal.
- C. The insulation shall be covered with a smooth, weatherproof, embossed aluminum jacket with integral Kraft-polyethylene vapor barrier separating the insulation from the metal. The factory applied aluminum jackets shall be at least .016 inches thick for interior installation and at least .031 inches thick for exterior installation. They shall be at least 36" long as measured along the pipe.
- D. Circumferentially, the width of the sheets shall be 1/2" to 2" greater than the circumference of the pipe insulation, with a Pittsburgh locktype on the longitudinal edge.
- E. The metal jackets shall be held in place by .020" thick, 3/4 inch wide, metal bands on 9" centers.
- F. Special care shall be taken to make all exterior insulation jackets completely waterproof by the use of an appropriate silicone base sealant at all joints, etc.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 61 21.72

FIELD TESTING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 61 21 – Process Control System Testing
- C. Section 40 61 21.71 – Factory Witness Test
- D. Section 40 61 21.73 – Final Acceptance Test

1.03 GENERAL REQUIREMENTS

- A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
 - 1. Each final control element shall be individually tested as specified hereinafter.
 - 2. Each control loop shall be tested as specified hereinafter.
 - 3. Each control strategy shall be tested under automatic digital control as specified hereinafter.
 - 4. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.
- B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
- C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.
- C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.
- D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

1.05 FINAL CONTROL ELEMENT TESTING

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFDs, that require turndown limits shall be initially set during this test.
- C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.06 LOOP CHECKOUT

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the

operator workstation or loop controller level, for continuity and for proper operation and calibration.

- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.
- C. The accuracy of all DACs shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADCs shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.
- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.07 CONTROL SYSTEM STARTUP AND TESTING

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.
- F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely

and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
- H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.08 FACILITY STARTUP COORDINATION

- A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
- B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.
- C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.
- D. At least one qualified control systems technician shall be provided for control system startup and test activities and at least two when loop checkout is being performed.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 61 23
SIGNAL COORDINATION REQUIREMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall conform to the signal coordination requirements specified herein.
- B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, and the instrumentation subcontractor.
- C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLCs and Control System PLCs.
- D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLCs, the Control System, etc.

1.02 ANALOG SIGNAL TRANSMISSION

- A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 VDC.
- B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
- C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.
- D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.
- E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliamperes signal.
- F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

- G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.
- H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.03 DISCRETE INPUTS

- A. All discrete inputs to equipment and Control and Information System PLCs, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLCs, unless specified otherwise.
- B. Sensing power (wetting voltage) supplied by the PLC shall be 24 VDC.

1.04 DISCRETE OUTPUTS

- A. All discrete outputs from local control panels and Control and Information System PLCs to field devices, starters, panels, etc., shall be 24 VDC powered (sourced) from PLCs.
- B. PLC powered discrete outputs shall energize 24 VDC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The 24 VDC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.
- C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.
- D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.05 OTHER DISCRETE SIGNALS

- A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.
- B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.

D. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 61 90
SCHEDULES AND CONTROL DESCRIPTIONS, GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all hardware and software required to provide the Control and Information System as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 91 – Process Control System Instrument List
- B. Section 40 61 93 – Process Control System Input/Output List
- C. Section 40 61 96 – Process Control Descriptions

PART 2 – CONVENTIONS

2.01 PLANT NUMBERING SYSTEM

- A. The plant equipment numbering system is based on a 5-digit code preceded by an equipment identification prefix and followed by a parallel designation suffix. The numbering system is broken down as follows:

$$\text{XXXX}^1 - \text{X}^2 \text{X}^3 \text{XXX}^4 \text{XXXX}^5$$

Where XXXX ¹ =	Where X ² =	Where X ³ =	Where XXX ⁴ =	Where XXXX ⁵ =
Equipment Prefix (1)	Major Process of Area (2)	Sub-Process (3)	Individual Equipment Item Number (4)	Parallel Designation Suffix (5)

1. Prefix letters are added as required to label a piece of equipment or describe instrumentation/control signal types. Instrumentation prefixes shall use the convention shown in the following table.

Instrument Prefix Letters

First Letter			Succeeding Letters		
Letter	Measured or Initiating Variable	Modifier	Readout or Passive Function	Output Function	Modifier
A	Analysis		Alarm or plc/dcs discrete alarm input		
B	Burner, combustion		User's choice	User's choice	User's choice
C	Conductivity (electrical)			Control or plc/dcs analog output	
D	Density (mass) or specific gravity	Differential			
E	Voltage (emf)		Primary element		
F	Flow	Ratio (fraction)			
G	User's choice		Glass or viewing device		
H	Hand (manually initiated)				High
I	Current (electrical)		Indicate or plc/dcs analog input		
J	Power	Scan			
K	Time or time schedule	Time rate of change		Control station	
L	Level		Light (pilot)		Low
M	Moisture or humidity	Momentary			Middle or intermediate
N	User's choice		Notify or plc/dcs discrete status input	User's choice	User's choice
O	User's choice		Orifice (restriction)		
P	Pressure or vacuum		Point (test connection)		
Q	Quantity	Integrate or totalize	Integrate or totalize		
R	Radiation		Record or print		
S	Speed or frequency	Safety		Switch	
T	Temperature			Transmit	
U	Multivariable		Multifunction	Multifunction	Multifunction
V	Vibration or mechanical analysis			Valve, damper or louver	
W	Weight or force		Well		
X	Unclassified	X axis	Unclassified	Unclassified or plc/dcs discrete output	Unclassified
Y	Event, state or presence	Y axis		Relay, compute, or convert	
Z	Position, dimension	Z axis		Drive, actuator or unclassified final control element	

2. Individual equipment item numbers are assigned per equipment type and shall use the following numbering convention:
 - a. 000-099 – Mechanical Equipment
 - b. 100-199 – Gates
 - c. 200-399 – Valves
 - d. 400-599 – Instrumentation
 - e. 600-799 – Electrical
 - f. 800-899 – HVAC
 - g. 900-999 – Miscellaneous
3. The parallel designation suffix shall be used to differentiate items of similar function and service that would otherwise have the same number. The suffix shall use the following conventions depending on application:
 - a. {none}
 - b. A, B, C,...
 - c. A1, A2, A3,...B1, B2, B3,...C1, C2, C3,...

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 61 91
PROCESS CONTROL SYSTEM INSTRUMENT LIST

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 90 – Schedules and Control Descriptions, General
- B. Section 40 61 93 – Process Control System Input/Output List
- C. Section 40 61 96 – Process Control Descriptions

PART 2 – PRODUCTS

2.01 NAMEPLATES

- A. Items of equipment listed in the instrument schedule, control panels, and digital hardware items shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include, as necessary, the equipment identification number, description, calibrated range, and set point(s). Abbreviations of the description shall be subject to the Engineer's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background. Nameplates attached to instruments may be black laser etched 1/8-inch high text on stainless steel with sharp edges made smooth. Stamped text shall not be acceptable.
- C. Nameplates shall be attached to metal equipment by NEMA rated stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of a braided stainless steel wire affixed with a permanent crimp.
- D. Submit sample nameplate of each type.

PART 3 – INSTRUMENT SCHEDULE

Inline Magnetic Flow Meters – Section 40 71 13.13

Tag Number	Service Description	State/Span	Remarks
2101	Filter Effluent	0-2000 gpm	IP68 Rating for Submergence

Residual Chlorine Analyzer – Section 40 75 21

Tag Number	Service Description	State/Span	Remarks
1080	Residual Chlorine (Post DCB)	0-5 mg/L	IP66 Rating

END OF SECTION

SECTION 40 61 96
PROCESS CONTROL DESCRIPTIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.
- B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.
- C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.
- D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through individual equipment suppliers.
- E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the electrical subcontractor under Division 26. The electrical subcontractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 14 00 – Coordination with Owner's Operations
- B. Section 40 61 90 – Schedules and Control Descriptions, General
- C. Section 40 61 91 – Process Control System Instrument List
- D. Section 40 61 93 – Process Control System Input/Output List

PART 2 – FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

2.01 DEFINITIONS

- A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).
- B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).
- C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as over torque, overtemperature, low oil pressure, high vibration, etc.
- D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

2.02 CONVENTIONS

- A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:
 - 1. Running/On/Open: Red
 - 2. Auto/Ready: White
 - 3. Stopped/Off/Closed: Green
 - 4. Fail/Alarm: Amber
 - 5. Generic Status: Blue or White

2.03 PROCESS CONTROL

- A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.
- B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:
 - 1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.
 3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).
 4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.
- C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the operator workstations.
- D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.
- E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.
- F. A control discrepancy alarm shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.
- G. An instrument failure alarm shall be generated for any instrument which is generating a signal that is less than 4 mA or greater than 20 mA.
- H. Unless otherwise specified in an individual control description, an instrument failure or control discrepancy alarm shall cause the control strategy to maintain last values and to generate an alarm. Manual initiation of the automatic control strategy shall be required.
- I. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.
- J. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

PART 3 – FUNCTIONAL CONTROL DESCRIPTIONS

3.01 Chlorine Dosing at Filter Effluent

- A. **Process Overview:** As filtered water leaves the filter and enters the filter effluent channel it is collected in the Filtered Effluent (FE) pipe which passes through the Chlorine Room. When the operator manually sets the ball valves on the chlorine dosing point to the FE line, chlorine is dosed into this line at a rate controlled by the PLC. The chlorine residual is monitored by the new chlorine analyzer (AE1080) and chlorine dose is adjusted by the PLC to the user input setpoint using a PID loop. The PLC will display the calculated disinfection CT. The calculation of CT is based on volumes of the pipe, volume of the DCB, plant flow rate, water temperature, pH, and residual chlorine measurement.

END OF SECTION

SECTION 40 71 13.13
INLINE MAGNETIC FLOW METERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Furnish one spare signal converter.

PART 2 – PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

- A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction and shall produce DC signals directly proportional to the liquid flow rate.
- B. Each meter shall be furnished with a 316 stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, hard rubber, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.
- C. The flow tube shall be provided with flush mounted electrodes of sufficient quantity to allow for full-bore measurement across the entire rated range of flow with zero pipe diameters for both inlet and outlet. Measurement shall have a maximum rated error of $\pm 0.5\%$ across the entire rated flow.
- D. Grounding rings shall be provided for both ends of all meters.
- E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

- F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68 and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. The associated transmitter shall be located in an area not subject to submergence.
- G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.
- H. The transmitter's preamplifier input impedance shall be a minimum of 109-1011 ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.
- I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.
- J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.
- K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.
- L. Accuracy shall be 0.30% of rate over the flow velocity range of 1.0 to 10.0 m/s (3.0 to 33 ft/sec) and 0.5% between 0.1 m/s and 1.0 m/s (1-3 ft/s). Repeatability shall be + 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.
- M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer.

Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

- N. Magnetic flow meter systems shall be Model W400, 0 x DN option by Endress+Hauser or equivalent by Rosemount, ABB, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

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SECTION 40 73 13
PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 79 00 – Miscellaneous Instruments, Valves, and Fittings

PART 2 – PRODUCTS

2.01 PRESSURE GAUGES

- A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".
- B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed approximately 75% of the full-scale range.
- C. Features
 1. Mounting: ½" NPT, lower stem mount type
 2. Accuracy: 0.5% full scale
 3. Case: Solid front, black phenolic material
 4. Dial: White background and black letters
 5. Glass: Shatterproof
 6. Blow-out protection: Back
 7. Pressure element: stainless steel bourdon tube
 8. Movement: Stainless steel, Teflon coated pinion gear and segment

9. Gaskets: Buna-N

- D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.
- E. Gauge size shall be 4-1/2".
- F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 40 79 00 – Miscellaneous Instruments, Valves, and Fittings.
- G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A 1/2" isolation stainless steel ball valve shall be provided for each gauge assembly.
- H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 75 21
CHLORINE ANALYZERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the chlorine residual analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 TOOLS, SUPPLIES AND SPARE PARTS

- A. One complete calibration kit shall be provided and shall include a one-year supply of reagents for measuring free (or total) chlorine.
- B. One sample conditioning kit, including self-cleaning Y-strainer, pressure regulators, and Teflon tubing, shall be provided for each analyzer.

PART 2 – PRODUCTS

2.01 CHLORINE ANALYZER

- A. Chlorine analyzers shall employ a US EPA-approved method of measurement using DPD indicator and buffer solution and shall be capable of measuring free or total residual chlorine by changing the indicator and buffer solutions.
- B. Features
 - 1. Range: 0-5 mg/L free or total residual chlorine
 - 2. Accuracy: Better than $\pm 5\%$ of reading or ± 0.05 mg/L whichever is greater
 - 3. Repeatability: 0.05 mg/L
 - 4. Resolution: 0.01 mg/L
 - 5. Sample Flow: 100-500 mL/min. (recommended sample flow rate setting shall be 250-300 mL/min during the sample cell flushing cycle.)
 - 6. Sample Inlet Pressure: 120 psig Maximum
 - 7. Sample Temperature Range: 0-50°C
 - 8. Cycle Time: 2.5 minutes

9. Outputs:
 - a. Selectable for 0-10mV, 0-100mV, 0-1V or 4-20 mA.
 - b. 4-20 mA analog shall be isolated. Output span shall be fully programmable
 10. Diagnostics: Self-test diagnostics with alarm indication.
 11. Alarms:
 - a. Two set point alarms, instrument warning alarm, and system shutdown alarm.
 - b. Alarm shall be SPDT dry contact relay output rated at 5A, 230 VAC SPDT alarm relays.
 12. Power Requirements: 115/230 VAC, 50/60 Hz, switch selectable.
 13. Enclosure: Sensor and controller enclosures shall be rated NEMA 12 for wall or stanchion mounting.
- C. The analyzer shall be designed for 30-day unattended operation and shall use only one pint of each reagent per month.
- D. Residual chlorine analyzer shall be HACH Model CL17, or equal.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 78 00
PANEL MOUNTED INSTRUMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the panel mounted instruments, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 62 00 – Control and Information System Hardware, General
- B. Section 40 67 00 – Control System Equipment Panels and Racks

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

- A. Tools, supplies and spare parts shall be provided as specified. In addition, the following specific spare parts items shall be provided:
 - 1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.
 - 2. Five of each type of interposing control relay provided under this Contract.

PART 2 – PRODUCTS

2.01 OPERATORS

- A. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant. For Hazardous areas, control operators shall be rated NEMA 7.
- B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type, unless otherwise indicated.

- C. Pilot lights shall be of the proper control voltage, push-to-test LED type with lens and LED lamp colors as specified below.
 - 1. Red: stopped, off, or closed
 - 2. Green: running, on, or opened
 - 3. Amber: fault, alarm, or warning
 - 4. White: generic non-alarm status
 - 5. Blue: control power on
- D. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.
- E. Control operators for all equipment under this Contract shall be of the same type and manufacturer unless otherwise indicated. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal

2.02 ELECTRONIC INDICATORS

- A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure.
- B. Indicators shall be Red Lion Model IMP or APLCL, Precision Digital, or equal.

2.03 RELAYS

- A. Interposing control relays (CR)
 - 1. Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall

be furnished and installed to provide the monitoring and/or control functions specified herein.

2. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating.
3. Relay coils shall be 120 VAC or 24 VDC as required to interface with equipment.
4. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil.
5. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

B. Timing Relays (TR)

1. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays.
2. Timing relays shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, equivalent by Eaton/Cutler-Hammer, equivalent by Allen-Bradley, or equal.

2.04 TOTALIZERS

- A. Totalizing counters shall be provided for flush panel, spring-clip mounting. Face dimensions of the totalizing counters shall be no larger than 1-1/8-inches high by 2-inches wide. Totalizing counters shall contain eight digits. Height of the digits shall not be less than 5/32-inch. Numerals shall be white on a black background. The counter shall be non-resettable and shall be totally compatible for operation on the pulses supplied by the associated instrument or integrator. The totalizing counter shall be capable of a maximum count rate of 25 counts/second.
- B. Legend plates shall be provided for each of the totalizing counters with white letters on a black background with legends as specified below.
- C. Totalizing counters shall be manufactured by Kessler-Ellis, or equal.

2.05 ALARM HORNS

- A. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24

VDC. Horns shall be capable of producing 100 dB at 10 feet and shall have adjustable volume.

- B. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 79 00
MISCELLANEOUS INSTRUMENTS, VALVES, AND FITTINGS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation, the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.
- B. Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This Specification shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

1.02 SUBMITTALS

- A. Impulse piping layout and routing drawings
- B. Complete instrument assembly drawings showing orientation to installed process piping.

PART 2 – PRODUCTS

2.01 PROCESS TUBING

- A. Process, impulse, or capillary tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with 37 degrees Type 316 stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.
- B. Piping for closely coupling instruments to process seals shall be standard stainless steel NPT threaded piping or NPT tapped mounting blocks.
- C. A nickel-based lubricant shall be used on threaded stainless steel piping connections to prevent galling.

2.02 POWER, CONTROL, AND SIGNAL CABLES

- A. Power, control and signal wiring shall be provided under Division 26 of the Specifications, unless otherwise indicated.

2.03 CHEMICAL DIAPHRAGM SEALS

- A. Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Process Control System Instrument Lists for specific materials requirements.
- B. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries.
- C. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

2.04 ISOLATING RING SEALS

- A. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).
 - 1. Full Line Size Isolating Ring Seals
 - a. Where indicated, the sensor body shall be full line size wafer design.
 - b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.
 - c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site
 - d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.
 - 2. Tapped Isolating Ring Seals
 - a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.

- b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.
- c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

2.05 FILLING MEDIUM:

- A. The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10 degrees F to +150 degrees F.
- B. Filling medium shall be silicone unless oxidizing agents, such as sodium hypochlorite, are present, then halocarbon shall be used.

2.06 TAMPER EVIDENT PAINT

- A. Piping and screwed/bolted connections of instrumentation containing the filling medium shall be marked with a small continuous tick mark of tamper evident paint over each piping/instrument joint. Tamper evident paint shall be applied prior to instrument assemblies arriving on the job site. Disturbance of the joint shall break the paint.
- B. Instrument assemblies with broken paint or missing paint shall not be accepted and shall be repaired or replaced at no additional cost to Owner. Paint shall be Dykem Cross-Check or equal.

2.07 ISOLATION VALVES

- A. Isolation valves shall be 1/2 inch diameter ball valves, unless otherwise indicated, with a Type 316 stainless steel body, Type 316 stainless steel ball. Where 316 stainless steel is not compatible with the process fluid, materials of construction shall be suitable for the associated process fluid (e.g., PVC for chemical service).

2.08 ALARM ANNUNCIATION DEVICE

- A. Sirens:
 - 1. For Class I, Division 2 areas and non-hazardous areas:
 - a. Provide NEMA 4X and Class I, Division 2 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302GCX series with UTM tone module as manufactured by Federal Signal Corporation.

2. For Class I, Division 1 areas:
 - a. Provide NEMA 4X and Class I, Division 1 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.
 - b. Alarm horn shall be the SelecTone 302X series with UTM tone module as manufactured by Federal Signal Corporation.

B. Strobe Lights:

1. Strobes located within the same room, or otherwise visible from any shared frame of view, shall be synchronized per the requirements of NFPA 72. Strobes shall be synchronized by the strobe manufacturer's synchronization module. Strobe circuits shall not exceed the continuous duty current rating of the synchronization module. Synchronization module shall be Federal Signal Model SSM, Edwards Signaling Model EG1M-RM, or equal.
2. For Class I, Division 2 areas and non-hazardous areas:
 - a. Provide red strobe status indicator. Unit shall be rated NEMA 4X and Factory Mutual approved for a Class I, Division 2, Group D area. Unit shall contain a durable polycarbonate housing and be surface mount. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 225XST, Edwards Signaling Model 116DEGEX-FJ, or equal.
3. For Class I, Division 1 areas:
 - a. Provide red explosion proof dome covered strobe unit rated NEMA 4X and Factory Mutual certified for a Class I, Division 1, Group D area. Unit shall be UL listed. Strobe shall be powered from 24VDC.
 - b. Alarm strobe shall be Federal Signal Model 27XST, Edwards Signaling Model 116DEGEX-FJ, or equal. Compatible mounting hardware by the strobe manufacturer shall be furnished.
4. Lens color shall be as indicated on the Drawings.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 43 20 00
PUMPS – GENERAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Comply with the requirements of Section 46 00 00 – Equipment General Provisions.
- B. Pumps shall be provided complete with all accessories, special tools, spare parts, mountings, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.
- C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.
- D. All pumps provided under an individual specification section shall be by the same manufacturer unless otherwise indicated in the specification.
- E. All equipment for the pumps, including but not limited to motors, cans and bases, shall be provided as a complete unit by the pump Manufacturer.
- F. The pump supplier shall have unit responsibility for coordinating the proper pump mounting system with the Contractor to ensure stable pump operation free from abnormal vibration.
- G. The pump supplier shall include, in their bid, time, labor, materials and tools required for installation assistance, testing and start-up with the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01 42 00 – References.
- B. Pumping system equipment, installation and testing shall be in accordance with the following applicable codes, standards and guidelines. All codes, standards and guidelines shall be the latest version as of the date of project bidding.
 - 1. American National Standards Institute / Hydraulic Institute (ANSI/HI)
 - a. ANSI/HI 3.1-3.5 Rotary Pumps for Nomenclature, Definitions, Application and Operation
 - b. ANSI/HI 3.6 Rotary Pump Test

- c. ANSI/HI 9.6.1 Rotodynamic Pumps – Guideline for NPSH Margin
 - d. ANSI/HI 9.6.2 Rotodynamic Pumps for Assessment of Applied Nozzle Loads
 - e. ANSI/HI 9.6.3 Rotodynamic Pumps – Guideline for Operating Regions
 - f. ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values
 - g. ANSI/HI 9.6.5 Rotodynamic Pumps Guideline for Condition Monitoring
 - h. ANSI/HI 9.6.6 Rotodynamic Pumps for Pump Piping
 - i. ANSI/HI 9.6.8 Rotodynamic Pumps - Guideline for Dynamics of Pumping Machinery. Guidelines and recommendations included in ANSI/HI 9.6.8 shall constitute the minimum requirements for acceptance.
 - j. ANSI/HI 9.8 Rotodynamic Pumps for Pump Intake Design
 - k. ANSI/HI 11.6 Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical and Electrical Tests
 - l. ANSI/HI 12.1-12.6 Rotodynamic Slurry Pump for Nomenclature, Definitions, Applications and Operation
 - m. ANSI/HI 14.1-14.2 Rotodynamic Pumps for Nomenclature and Definitions
 - n. ANSI/HI 14.3 Rotodynamic Pumps for Design and Application
 - o. ANSI/HI 14.6 Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
2. American Society of Mechanical Engineers (ASME)
 - a. ANSI/ASME B73.1 Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process
 3. American Petroleum Institute (API)
 - a. ANSI/API Standard 610 Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
 4. American Water Works Association (AWWA)
 - a. ANSI/AWWA E103 Standard for Horizontal and Vertical Line-Shaft Pumps
 5. American Society for Testing and Materials (ASTM)

- a. A36 Specification for Structural Steel
 - b. A48 Specification for Gray Iron Castings
 - c. A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - d. A148 Specification for Steel Castings, High Strength, for Structural Purposes
 - e. A193 Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
 - f. A276 Specification for Stainless Steel Hot/Cold-Finished Bars
 - g. A322 Specification for Steel Bars, Alloy, Standard Grades
 - h. A514 Specification for High Yield Strength, Quenched and Tempered alloy Steel Plate, Suitable for Welding
 - i. A532 Specification for Abrasion-Resistant Cast Irons
 - j. A536 Specification for Ductile Iron Castings
 - k. A565 Specification for Martensitic Stainless Steel Bars
 - l. A582 Specification for Free-Machining Stainless and Heat-Resisting Steel Bar, Hot-Rolled and Cold-Rolled
 - m. A743 Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel and Nickel-Base, Corrosion-Resistant for General Application
 - n. B148 Specification for Aluminum-Bronze Sand Castings
 - o. B584 Specification for Copper Alloy Sand Castings for General Application
- 6. American National Standards Institute (ANSI)
 - a. B16.1 Standard for Cast Iron Pipe Flanges and Flanged Fittings
 - b. B16.5 Standard for Pipe Flanges and Flanged Fittings
 - 7. American National Standards Institute / National Fire Protection Association (ANSI/NFPA) 70 National Electric Code
 - 8. Society of Automotive Engineers (SAE) J404 Chemical Compositions of SAE Alloy Steels

9. International Organization for Standardization (ISO), Standard, ISO 1940 – Mechanical Vibration – Balance quality requirements for rotors balance quality grade for rotors in a constant rigid state.
10. Comply with the requirements of Section 46 00 00 – Equipment General Provisions.

C. Related contract specification sections:

1. Section 01 33 00 – Submittal Procedures
2. Section 46 00 00 – Equipment General Provisions
3. Division 26 – Electrical
4. Section 26 05 60 – Low Voltage Electric Motors
5. Division 40 – Process Interconnections

1.03 ACTION/INFORMATIONAL SUBMITTALS

A. Product Data:

1. Comply with Section 01 33 00 – Submittals.
2. Fabrication information.

B. Provide submittals identified in Specification Section 46 00 00 – Equipment General Provisions in addition to the submittals identified herein and in addition to the submittals identified in the individual pumping specification sections.

C. Shop Drawings shall include the following information in addition to the requirements of Section 01 33 00 – Submittal Procedures and shall include the following information in addition to the requirements of Section 01 33 00 – Submittal Procedures:

1. Pump name, identification number and specification number.
2. Performance characteristics and descriptive data, including but not limited to:
 - a. Pump performance curves at rated speed and reduced speeds (if reduced speeds are specified).
 - b. Pump performance data shall be provided for the proposed impeller diameter and for the maximum impeller diameter possible with the proposed pump.
 - c. Curves shall indicate:

- 1) Information specified elsewhere
- 2) Impeller diameter
- 3) Minimum continuous stable flow (minimum flow to avoid suction recirculation)
- 4) Preferred operating region (POR) per ANSI/HI 9.6.3
- 5) Allowable operating region (AOR) per the latest version of ANSI/HI 9.6.3.
- 6) Performance curves submitted shall be for the entire pump assembly, including efficiency corrections and losses.
- 7) Pump performance curves shall be submitted both in the form of performance data cut sheets and in tabular format. Tabular data shall include the following:
 - a) Flow
 - b) Pump head (pressure for positive displacement type pumps)
 - c) NPSH required (net positive inlet pressure, NPIP, for positive displacement type pumps)
 - d) Pump efficiency
 - e) Rated driver horsepower
 - f) Brake horsepower
 - g) A minimum of 10 data points shall define rotodynamic pump performance curves listed above. Performance curve data points shall include the following:
 - i. best efficiency point
 - ii. all specified operating points
 - iii. preferred operating region minimum and maximum
 - iv. allowable operating region minimum and maximum
 - v. shutoff condition
 - vi. runout

- vii. The remainder of the points shall be distributed evenly to clearly define the shape of each of the curves.
 - viii. Each data point shall be reported to a minimum of three (3) significant figures.
 - ix. The curve data shall align with the HI acceptance grade (1B, 2B, 1U, etc.) as specified in the individual pump specification and shall explicitly state the applicable tolerance band, as defined by the Hydraulic Institute Standards, associated with each value.
3. Minimum submergence requirements shall be provided for vertically suspended pumps and submersible pumps.
4. Detailed dimensional drawings, data and setting plans including but not limited to:
 - a. General cutaway sections
 - b. Materials
 - c. Dimension of shaft projections
 - d. Shaft and keyway dimensions
 - e. Shaft diameter
 - f. Shaft-impeller connection details
 - g. Dimension between bearings
 - h. General dimensions of pump
 - i. Suction head bolt orientation
 - j. Anchor bolt locations
 - k. Forces: Itemized forces shall be determined at specified operating points and at pump shutoff condition.
 - l. Assembly views
 - m. Exploded parts view
 - n. Cutaway images
 - o. Provide weight of entire pump assembly, including motor and base weight of individual major subassemblies. Indicate the weight of each component, and

total static and dynamic loads imparted by the equipment to the supporting structure. Itemized loads shall be determined at specified operating points and at pump shutoff condition.

- p. Impeller
 - q. Drawings shall identify each component by tag number to which the catalog data and detail sheets pertain.
 - r. Mass of rotating assembly
 - s. Mass of coupling(s)
5. Drive and motor data as required by Division 26 – Electrical. Complete motor data shall include but not be limited to:
- a. Size
 - b. Make
 - c. Mass of motor
 - d. Inertia of driver
 - e. Motor enclosure type
 - f. Characteristics
 - g. Wiring diagrams
 - h. Variable speed drive information and data: Where pump and motor speeds are to be regulated by variable speed drives, the CONTRACTOR shall coordinate, furnish and exchange all necessary requirements with the respective equipment manufacturers to ensure compatibility and shall submit pump, motor and variable speed drive shop drawings together as a complete system.
6. Information on pumps and motor bearings, including but not limited to:
- a. Bearing types
 - b. Rated bearing life
 - c. Bearing life calculations for the specified operating points.
 - d. Bearing arrangement
7. Gear box design and performance criteria and AGMA service factor.

8. Equipment protective device details and connection diagrams.
 9. Details of shaft sealing system including seal/packing type, seal water control devices, and seal water piping schematic.
 10. Information on pump appurtenances including but not limited to:
 - a. Couplings
 - b. Shaft guards
 - c. V-belt drive systems
 11. Submersible pump submittals shall also include:
 - a. Product data sheets for power and control cables, length of cables and cable support system.
 - b. Details on pump guide rail system and mounting requirements.
 - c. Details on submersible pump's retrieval system.
 12. Any additional information required to demonstrate compliance with the specifications.
- D. Results of structural, lateral, and torsional dynamic analyses as required herein and in the individual specification sections.
- E. Manufacturers literature and brochures
- F. Lubrication Information: Complete lubrication instructions and lubricant schedule, including manufacturer's recommended lubricant. All lubricants shall be food grade, NSF 61 approved. Schedule shall include frequency of lubricant application, type of lubricant, and instructions regarding lubricant application. Comply with Section 46 00 00 – Equipment General.
- G. Materials of construction data and associated specifications (such as AISI, ASTM, SAE, etc.), including but not limited to:
1. Grade
 2. Type
 3. Elemental makeup, by percent elemental constituent
 4. Mechanical properties, including but not limited to:
 - a. Brinell hardness number

- b. Galling resistance
- H. Coatings: Coating system data and description of coating system, surface preparation and shop painting, including certification that the shop paint is compatible with the finish paint.

1.04 CLOSEOUT SUBMITTALS

- A. Submit warranty documentation in compliance with:
 - 1. Section 01 33 00 – Submittals
 - 2. Section 01 75 00 – Checkout and Startup Procedures
- B. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01 33 00 – Submittal Procedures and Section 01 78 23 – Operation and Maintenance Data.

1.05 MAINTENANCE MATERIALS SUBMITTALS

- A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with:
 - 1. Section 01 33 00 – Submittal Procedures.
 - 2. Section 01 78 23 – Operation and Maintenance Data.
- B.
- C. Comply with Section 46 00 00 – Equipment General.

1.06 QUALITY ASSURANCE SUBMITTALS

- A. Dynamic Analysis Submittals:
 - 1. Dynamic analysis entity qualifications: Qualifications shall be submitted in advance of dynamic analysis calculations, models and analyses. Qualifications shall include but not be limited to:
 - a. Detailed tabulation of relevant projects with descriptions and data to clearly substantiate that the qualifications specified herein this section are satisfied by the dynamic analysis firm and individuals. For each project, tabulation shall include:
 - 1) Proposed personnel who worked on project experience item.
 - 2) Resumes of proposed personnel including which project experience items they have experience working on.

- 3) Pump end user point of contact including name and email address.
2. Dynamic analysis input data requirements as defined in ANSI/HI 9.6.8, Appendix B.
 3. Dynamic analysis results as required herein and as follows:
 - a. For vertical motors, where dynamic analysis is specified, submit the following additional information:
 - 1) Expected/Proposed reed critical frequency (RCF) data:
 - a) Motor reed critical frequency (RCF)
 - b) Force due to the weight of the motor
 - c) Center of gravity location (the distance to the motor center of gravity from the motor flange face)
 - d) The static deflection of the motor center of gravity, y_{static}
 - e) Expected and proposed values shall be provided by the motor manufacturer to the pump manufacturer, to the Engineer, and to the dynamic analysis entity.
 - 2) Report of post-manufacture/pre-shipment motor reed critical frequency (RCF) factory impact verification test: Post-manufacture/pre-shipment motor impact test results (per HI 9.6.8, Appendix D) (for vertical pumps where a dynamic analysis is specified), including but not limited to the following information:
 - a) Mounting plate structure natural frequency (without motor)
 - b) RCF in two perpendicular planes:
 - i) In-line with the conduit box;
 - ii) Perpendicular to the conduit box.
 - c) Motor weight
 - d) Motor center of gravity location (the distance to the motor center of gravity from the motor flange face).
 - e) Photo of the motor test set-up with the motor in place
 - f) Vibration instrument used

- g) Impact device used
 - h) Weight scale information
 - i) Description of method used to determine motor center of gravity location
 - j) Post-manufacture, pre-shipment motor reed critical frequency (RCF)
 - 4. Report shall include model mesh sizes.
- B. Factory testing plan. Wherever factory tests are specified, testing plan shall include but not be limited to the following:
 - 1. Testing procedures
 - 2. Testing equipment
 - 3. Test arrangement
 - 4. Test conditions
 - 5. Speed of rotation of test
 - 6. Test facility systems and equipment, including but not limited to:
 - a. Test facility electrical single line diagram
 - b. Calibrated factory motor (where applicable) with calibrated efficiency curves
 - c. Calibrated factory drive (where applicable) with calibrated efficiency curves
- C. Factory Test Results shall be submitted and approved prior to shipment of equipment.
- D. Shipment, Delivery, Handling and Storage instructions
- E. Installation instructions
- F. Field testing plan
- G. Comply with Section 01 75 00 – Check Out and Start Up Procedures
- H. Preliminary field test data
- I. System field quality control testing
- J. Final field test data

- K. Certified test reports
- L. Startup report including data substantiation of successful completion of 30-day operational demonstration performance data.

1.07 GENERAL INFORMATION AND DESCRIPTION

- A. Comply with Section 46 00 00 – Equipment – General Provisions.

1.08 DYNAMIC ANALYSIS – NOT USED

1.09 WARRANTY

- A. Warranty requirements are supplementary to the individual equipment specifications.
- B. Comply with the Equipment Warranties requirements specified in Section 46 00 00 – Equipment General Provisions.

1.10 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS:

- A. When operating at the maximum output speed each pump shall have a characteristic performance curve which meets the conditions listed in the pump schedule. The pumps and drive motors shall be capable of operating satisfactorily under the full-range of speed, flow and pressure conditions as defined by the pump schedule. Pump efficiency as defined herein shall include all mechanical losses from bearings and shaft seals.
- B. The impeller diameter required for the specified operating conditions shall not exceed 95% of the maximum impeller diameter of the pump provided to allow increased duty for future conditions. **ALTHOUGH IT IS DESIRABLE TO HAVE FLEXIBILITY TO INCREASE PUMP CAPACITY, IT MAY NOT BE POSSIBLE TO MAINTAIN 95% OF MAX IMPELLER FOR ALL PUMP SELECTIONS.**
- C. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to backflow, including but not limited to back spinning from a dead stop and/or via a flow reversal condition that occurs immediately subsequent to a forward flow condition, through the pump with the primary TDH specified available at the pump discharge flange. Maximum reverse run-away speed shall not exceed 130 percent of the design operating speed.
- D. Pump manufacture shall certify a Minimum Continuous Stable Flow (MCSF) rating at maximum speed that is lower than the specified minimum operating flow. Where a reduced speed operating condition is specified, the manufacturer shall also certify MCSF at the pump speed required to meet this condition.
- E. Factory test acceptance grade for rating point shall be as specified herein, except where superseded via specification and/or scheduled values in the individual pump specifications, however power required shall not exceed the rated motor horsepower.

- F. Pump Operating Conditions: Refer to respective individual pump specifications for specific performance requirements.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or drive. Safety factors will not be considered in determining compliance with this requirement.
- B. Suction and discharge flanges shall conform to ASME B16.1 or B16.5 dimensions.
- C. For pumps in raw sewage service and as required by individual pump specifications, handholes shall be provided on the pump suction nozzle and the pump volute and shall be shaped to follow the contours of the casing or adjoining piping to avoid any obstructions in the water passage.
- D. The minimum ABMA L10 bearing life for all pump, motor and drive bearings shall be 60,000 hours unless otherwise specified in the individual pump specification sections.

2.02 ANCHORS AND SUPPORTS

- A. Comply with the following Specification Sections:
 - 1. Specification Section 05 05 23 – Metal Fastening.
 - 2. Specification Section 46 00 00 – Equipment General Provisions.
 - 3. Comply with individual pump specifications.
- C. [Specification Section 01 73 23 – Anchorage and Bracing of Non-Structural Components (applies to all states except Florida)]

2.03 DEFAULT MATERIALS

- A. Pumps shall be constructed out of the materials specified in respective individual pumping specification sections. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

Component	Materials of Construction
Casings and Bowls	Close-grained gray cast iron, conforming to ASTM A 48, or equal

Component	Materials of Construction
Impellers	Water: ASTM B 148, aluminum bronze Wastewater: ASTM A 536, Hard Iron
Shafts, wetted	Type 400 series stainless steel
Shafts, non-wetted	AISI 4140 steel
Miscellaneous stainless steel parts	Type 316 series stainless steel
Anchor Bolts and Fasteners	Type 316 stainless steel

2.04 COMPONENTS:

- A. Refer to individual specification sections for specific requirements.
- B. Pump Shaft:
 - 1. The shaft shall be heat treated, turned, ground, and polished over its entire length and shall be provided with keyways on both ends.
 - 2. The shaft shall be sufficiently large in diameter to safely transmit the maximum torque developed by the drive unit and provide a rigid support for the impeller to prevent excessive vibration.
- C. Bearings:
 - 1. Bearings shall be designed for continuous heavy duty loads and for both axial and radial thrust loads.
 - 2. The specified ABMA L-10 life for bearings shall be under worst possible operating conditions.
 - 3. Bearings shall support the shaft and the complete rotating elements.
- D. Wear Rings:
 - 1. Wear rings shall meet or exceed the requirements of API 610, including but not limited to the following features:
 - a. Brinell hardness and Brinell hardness difference between adjacent wear parts.
 - b. Wear ring clearances
 - 2. Adjacent wear ring material combinations shall be non-galling.

2.05 STRUCTURAL STEEL

- A. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, and to pertinent ASTM Standard Specifications.

2.06 DISSIMILAR METALS

- A. All dissimilar metals shall be isolated in accordance with Section 05 10 00 – Metal Materials and to the satisfaction of the Engineer.

2.07 STANDARDIZATION OF GREASE FITTINGS

- A. Grease Fittings: Comply with Section 46 00 00 – Equipment General Provisions.

2.08 APPURTENANCES

- A. Seals:
 - 1. Mechanical seals shall be furnished as specified in individual pumping equipment sections.
 - 2. If the pump manufacturer recommends a better seal or alternate flushing arrangement for a specific application, it may be submitted to the Engineer for approval in accordance with the requirements of Section 01 25 00 – Substitution Procedures.
- B. Pressure Gauges:
 - 1. Contractor shall supply all pressure gauges for all pumps by one manufacturer.
 - 2. Gauges shall be provided through the instrumentation subcontractor to match other gauges on the project.
 - 3. Gauges shall be as specified in Section 40 73 13 – Pressure and Differential Pressure Gauges.
 - 4. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 40 79 00 – Miscellaneous Instruments, Valves and Fittings.
 - 5. The Contractor shall furnish and install pressure gauges as shown on the Drawings, but the following gauges shall be provided as a minimum:
 - a. On the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.

- b. On the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.
6. Gauge ranges shall be coordinated with the pump manufacturer and shall meet the following requirements, except where otherwise specified:

Location	Type	Graduation	Suction Range	Discharge Range
Suction	Single Scale, Compound	FT H20	-34-FT	+34-FT
Discharge	Single Scale	FT H20	0-FT	Greatest of the following: - Shutoff + 5-FT - 130% of Maximum

C. Shaft Couplings:

- 1. Except as otherwise specified in individual pump specification sections, flexible couplings for direct driven pumps shall provided between the pump shaft and driver and keyed to pump and driver shafts. Flexible couplings shall be internal metal grid type couplings with a metal flange on both shafts with a metal cage in between, as manufactured by Falk, or equal.
- 2. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.
- 3. Comply with Section 46 00 00 – Equipment General Provisions protective guard requirements.

D. Equipment Guards: Provide guards in accordance with OSHA requirements for all rotating assemblies that would otherwise be exposed at the operating deck level.

E. Provide access to:

- 1. Couplings
- 2. Oil drains

2.09 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 26 - Electrical specifications and the latest National Electric Code.

- B. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation. The use of service factor will not be allowed in determining overloaded condition.
- C. In the individual pump specifications, specified motor horsepower is intended to be the maximum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.
- D. Where variable frequency drives (VFDs) and/or variable speed drives (VSDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD/VSD supplier to ensure a complete and operational system. VFDs/VSDs shall be furnished under Division 26 - Electrical unless otherwise specified in the pump specification.
- E. Motor starters and controls shall be furnished and installed under Division 26 - Electrical and Division 40 - Process Interconnections unless otherwise specified in the individual pump specifications.

2.10 SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications and/or where recommended by the equipment manufacturer.
- B. Spare parts shall be identical and interchangeable with original parts.
- C. The Contractor shall furnish a one-year supply of all recommended lubricating oils and greases.
- D.

2.11 EQUIPMENT IDENTIFICATION

- A. Comply with the requirements of Section 46 00 00 – Equipment General Provisions.
- B. All pumps shall be provided with a stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with:
 - 1. the manufacturer's name
 - 2. year of manufacture
 - 3. model number
 - 4. serial number
 - 5. principal rating data including the following at the primary design point:

- a. Capacity in gallons per minute
 - b. rated total dynamic head
 - c. speed in rotations per minute
 - d. efficiency at the primary design point.
- C. Each pump shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump – 1 (RWP-1)". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.
- D. Nameplates shall not be painted over.

PART 3 – EXECUTION

3.01 SHOP TESTING

- A. The terms Shop Testing and Factory Testing shall be considered to be interchangeable.
- B. Perform Shop Testing in conformance with Section 46 00 00 – Equipment General Provisions.
- C. The CONTRACTOR shall be responsible for the coordination of factory testing of each pump, variable speed drive, and motor. Unless required as indicated by the individual pump specification sections, manufacturer provided factory test motors and factory variable speed controllers (as necessary) shall be used for factory performance testing.
- D. Except as otherwise specified, factory testing shall be conducted in accordance with the latest version of
- 1. ANSI/HI 14.6.
 - 2. For submersible pumps, testing shall be conducted in accordance with the latest version of ANSI/HI 14.6 and ANSI/HI 11.6.
 - 3. For rotary pumps, testing shall be conducted in accordance with the latest version of ANSI/HI 3.6.
 - 4. Pumps shall be tested within plus or minus 3 percent of the pump design speed. Affinity laws shall be used to adjust performance within this range to the design condition hydraulics.
- E. Hydraulic Performance Acceptance Tests

1. The testing procedure shall be submitted to the Engineer for review and approval before scheduling the testing. The Owner/Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.
2. Notification and payment of expenses for witness testing shall be as described in Section 46 00 00 – Equipment General Provisions wherever individual pump specifications call for witness testing.
3. Specified hydraulic operating condition tolerances for rotodynamic pumps shall be as follows unless otherwise specified in the individual pump specifications:
 - a. The design or rated pump operating point shall be within the tolerances specified for Acceptance Grade 1U as defined by ANSI/HI 14.6.
 - b. The specified low flow pump operating point shall have a unilateral positive head tolerance; no negative head tolerance is allowed at the defined flow condition.
 - c. The specified high flow pump operating condition shall have a unilateral positive flow tolerance; no negative flow tolerance is allowed at the defined head condition.
4. Factory performance test shall include a minimum of seven test points between shutoff and runout.
5. Where required by the individual equipment specification sections, NPSH (NPIP for rotary pumps) tests shall be conducted to demonstrate compliance with the specified NPSH (NPIP for rotary pumps) requirements.
6. Net Positive Suction Head Testing for rotodynamic pumps shall be as follows unless otherwise specified in the individual pump specifications:
 - a. An NPSH test for a single operating condition shall be executed. The test flow shall be greater than the specified high flow operating condition and shall be identified by increasing the flow until a 3% drop in head occurs relative to the expected head if sufficient NPSH were available.
 - b. If during the NPSH test the pump's maximum flow condition is reached prior to identification of the NPSH3 value (i.e., control valve is fully open or the pump is operating at the edge of the AOR), the NPSHa at that operating condition shall be documented as the maximum NPSH3 value.
7. Certified test curves shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications.
 - a. Certified curves shall identify minimum continuous stable flow and preferred operating region (POR) and allowable operating region (AOR) per the latest version of ANSI/HI 9.6.3.

- b. Certified performance curves shall include the NPSH3 value identified during testing. An NPSH3 curve shall be calculated over the pump's AOR based on the documented test value(s). A clear designation shall be provided on the certified performance curve indicating calculated portions of the NPSH curve.
- 8. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.
- 9. All instruments shall be calibrated as required by ANSI/HI 14.6, 11.6, or 3.6 as applicable.
- F. Where required in the individual pump specifications, a certified hydrostatic test shall be completed on each pumping unit in accordance with ANSI/HI 14.6 or 11.6 as applicable. Hydrostatic test pressure shall be 1.5 times maximum operating head or 1.25 times shutoff head, whichever is greater.
- G. Where required in the individual pump specifications, each individual casting shall be Brinell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a registered professional engineer.
- H. Shop testing of electric motors shall conform to:
 - 1. Section 46 00 00 – Equipment General Provisions
 - 2. Section 26 05 60 – Low-Voltage Electric Motors
 - 3. Section 26 05 00 – Basic Electrical Requirements
 - 4. Post-manufacture, pre-shipment motor impact test results (per HI 9.6.8, Appendix D) (for vertical pumps where a dynamic analysis is specified). Motor Reed critical frequency (RCF) mass and center of gravity properties shall be verified at the motor manufacturer's facility via motor impact testing. Before shipment of motor from motor factory, submit report of impact test results.
 - 5. The accuracy of post-manufacture, pre-shipment motor impact test RCF shall be within 10% +/- of the expected/proposed values obtained from the motor manufacturer during the motor proposal phase. If/where values are out of tolerance, dynamic analyses and forced response analyses shall be repeated and adjustments to equipment made until a result that conforms with HI 9.6.8 and this specification is demonstrated via submitted data and accepted via the submittal process.
- I. Shop testing of pumping trains - The right is reserved to require factory impact tests pre-shipment.

1. Post-manufacture, pre-shipment impact test results (per HI 9.6.8, Appendix D) (for pumps where a dynamic analysis is specified). Natural frequencies shall be verified at the manufacturer's facility via impact testing. Before shipment of equipment from the point of manufacturer, submit report of impact test results.
2. The accuracy of post-manufacture, pre-shipment impact test shall be within 10% +/- of the expected/proposed values obtained from the manufacturer during the proposal phase. If/where values are out of tolerance, dynamic analyses and forced response analyses shall be repeated and adjustments to equipment made until a result that conforms with HI 9.6.8 and this specification is demonstrated via submitted data and accepted via the submittal process.

3.02 SHIPMENT, DELIVERY, HANDLING AND STORAGE

- A. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- B. Machined surfaces of all exposed pump openings or other exposed unpainted surfaces shall be protected by wooden blanks or Cosmoline, as appropriate, strongly built and securely bolted thereto.
- C. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer's field services shall be in accordance with:
 1. Section 01 75 00 - Checkout and Startup Procedures
 2. Section 46 00 00 - Equipment General Provisions
- B. Unless otherwise referenced in the individual pump specification section, as a minimum the services of the manufacturer's representative shall be provided for as stated in the following schedule:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	

- C. Any additional time required to achieve successful installation and operation shall be at the expense of the CONTRACTOR.

3.04 INSTALLATION

- A. Pumping equipment shall be installed in accordance with Section 46 00 00 – Equipment General Provisions, the manufacturer's recommendations, accepted procedures submitted with the shop drawings and as indicated on the Drawings, unless otherwise accepted by the ENGINEER.
- B. Level pump and motor and grout feet or baseplate with grout in accordance with Section 03 60 00 – Grout and in accordance with Section 46 00 00 – Equipment General. Ensure minimum grout depth is obtained as recommended by the pump and grout manufacturers.
- C. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with stainless steel pipe or copper tube (as appropriate for the environment), properly supported with brackets.
- D. Contractor shall have unit responsibility for the proper coordination, sizing, and installation of the pump foundation/mounting requirements based on the manufacturer's recommendations, subject to Engineer's review and comment.

3.05 ALIGNMENT

- A. Pumping equipment shall be aligned in accordance with Section 46 00 00 – Equipment General Provisions, the manufacturer's recommendations, accepted procedures submitted with the shop drawings and as indicated on the Drawings.
- B. Equipment shall be aligned and free from binding, scraping, excessive vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.
- C. As a minimum, comply with International Standard, ISO 1940 – Mechanical Vibration – Balance quality requirements for rotors balance quality grade for rotors in a constant rigid state.

3.06 FIELD TESTING

- A. Comply with Section 46 00 00 – Equipment General Provisions for applicable preliminary and final field testing requirements supplementary to those described in this specification.
- B. Comply with Section 01 75 00 – Checkout and Startup Procedures.
- C. All pumping units shall be field tested after installation, in accordance with the Contract Documents, to demonstrate satisfactory operation over the full operating speed range, without excessive noise, vibration, cavitation, and overheating of the bearings. The field testing shall be performed in the presence of an experienced field representative of the manufacturer of each major item of equipment, who shall supervise the following tasks

and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

1. Pumps shall be tested for vibration over the full specified speed range. Unless otherwise required by individual specification sections, vibration shall be within the limits identified in the latest version of ANSI/HI 9.6.4 (or ANSI/HI 11.6 for submersible pumps), or manufacturer's limits if more stringent. If vibration is greater than 80% of the limits identified in ANSI/HI 9.6.4, follow-up vibration testing shall be completed after a 90-day break-in period to ensure that vibration remains within ANSI/HI 9.6.4 allowable limits. If vibration exceeds the allowable limits during the follow up testing, modifications shall be made as a warranty repair.
2. Bearing temperatures shall be determined. A running time of at least 20 minutes shall be maintained for this test, unless liquid volume available is insufficient for a complete test.
3. In addition to dynamic analysis requirements specified and defined in HI 9.6.8, where Level 2 or Level 3 analysis is specified or otherwise specified in the individual pump specifications, the natural frequencies of each installed pump shall be determined using the "bump test" method. Field natural frequency testing shall demonstrate a minimum of 10% field separation from the 1x running speed, 2x running speed and vane pass frequencies. Field test information shall be incorporated into the models developed for this facility for confirmation purposes. In addition, pump train coast down testing shall be performed for comparison purposes to bump testing results.
4. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, motor power, flow, pump suction head, and pump discharge head, for at least five (5) pumping conditions at full speed. One of the points shall be within -5% and 0%, and one being within 0% and +5% of the rated condition point flow rate; the remaining three points shall be spaced over the allowable operating region of the pump performance curve with points taken at or near the maximum allowable (shutoff) head region and at or near the maximum allowable flow (runout). Additional reduced speed testing shall be performed to demonstrate that pumps can achieve performance at turndown conditions where specified in individual pump specification sections. Each power lead to the motor shall be checked for proper current balance. Flow shall be measured to the extent possible by permanently installed instrumentation or drawdown measurement. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing. Field performance testing shall meet HI 14.6 pump acceptance test grade tolerance band grade 3B for all required test points.

D. The field testing shall be witnessed by the Owner or its representative. The CONTRACTOR shall submit to the ENGINEER a written notification of all pump field

tests a minimum of one (1) week prior to testing. In the event of failure of any pump to meet any of the above requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional compensation, until found satisfactory. The CONTRACTOR shall then certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include date of final acceptance test, as well as a listing of all persons present during tests, and resulting test data. The costs of all Work performed in this Paragraph by factory-trained representatives shall be borne by the CONTRACTOR.

3.07 FAILURE OF EQUIPMENT TO PERFORM

- A. Comply with Section 46 00 00 – Equipment General Provisions.

3.08 PAINTING

- A. Comply with Section 46 00 00 – Equipment General Provisions.
- B.

END OF SECTION

SECTION 46 00 00
EQUIPMENT GENERAL PROVISIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all accessories as specified, as shown on the Drawings, and as required for a complete and operable system.
- B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.
- C. The Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to coordinate all interfaces related mechanical, structural, electrical, instrumentation, and control work and to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as shown and specified.
- D. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.
- E. The requirements of this section shall apply to equipment furnished under Divisions 40, 43, and 46.
- F. Comply with reference specifications, codes and standards as specifically modified, complimented, and supplemented herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01 42 00 – References along with those identified herein this and other individual specification sections.
- B. American Institute for Steel Construction (AISC)
- C. American National Standards Institute/American Bearing Manufacturers Association (ANSI/ABMA):
 - 1. ANSI/ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings
 - 2. ANSI/ABMA 11 – Load Ratings and Fatigue Life for Ball Bearings

- D. Acoustical Society of America (ASA) / American National Standard Institute (ANSI) S2.75, Shaft Alignment Methodology:
 - 1. Part 1: General Principles, Methods, Practices, and Tolerances
 - 2. Part 2: Vocabulary
 - 3. Part 3: Alignment of Vertically Oriented Rotating Machinery
 - 4. Guidelines and recommendations included in ASA/ANSI S2.75 shall establish and be interpreted as the minimum requirements for acceptance for leveling, grouting and alignment related work.
- E. American National Standards Institute / American Society of Mechanical Engineers (ANSI/ASME) Standard B29.1, Heavy Duty Offset Sidebar Transmission Roller Chains and Sprocket Teeth.
- F. American Welding Society (AWS):
 - 1. D1.1 "Structural Welding Code - Steel"
 - 2. D1.2 "Structural Welding Code - Aluminum" of the American Welding Society
- G. Electrical Apparatus Service Association, Inc. (EASA) Mechanical Reference Handbook (latest revision).
- H. Standard, ISO 1940 – Mechanical Vibration – Balance quality requirements for rotors balance quality grade for rotors in a constant rigid state.
- I. In the event of conflict between individual specifications and reference specifications, codes and standards, the more restrictive criteria shall govern.

1.03 ACTION/INFORMATIONAL SUBMITTALS

- A. Product Data:
 - 1. Comply with Section 01 33 00 – Submittals Procedures
 - 2. Fabrication information
- B. Provide submittals identified in individual equipment specification sections in addition to the submittals identified herein.
- C. Shop Drawings shall include the following information in addition to the requirements of Section 01 33 00 – Submittal Procedures and shall include the following additional information:
 - 1. Equipment name, identification number and specification number.

2. Performance characteristics and descriptive data, including but not limited to capacity, power, speed, torque, and efficiency.
3. Detailed equipment dimensional drawings and setting plans including but not limited to:
 - a. General cutaway sections
 - b. Materials of construction
 - c. Dimension of shaft projections
 - d. Shaft and keyway dimensions
 - e. Shaft diameter
 - f. Shaft connection details
 - g. Dimension between bearings
 - h. General dimensions of equipment
 - i. Anchor bolt locations
 - j. Forces
 - k. Assembly views
 - l. Weights: Provide weight of entire equipment assembly, including motor and base weight of individual major subassemblies. Indicate the weight of each component, and total static and dynamic loads imparted by the equipment to the supporting structure.
 - m. Rotating assembly technical information and illustration.
 - n. Drawings shall identify each component by tag number to which the catalog data and detail sheets pertain.
 - o. Drawings showing the location and type of all equipment, system components, supports, hangers, foundations and the required clearances to operate and maintain equipment, valves and system components in a code compliant, safe and ergonomic manner. Drawings shall show clearances reserved for walking access around all sides, for opening access doors fully, for visual inspection for condition monitoring, and for the performance of maintenance tasks including but not limited to changing filters, replacing belts, maintaining lubrication levels, predictive maintenance and performing diagnostic functions.

4. Drive and motor data as required by Division 26 – Electrical. Complete motor data shall include but not be limited to size, make, type and characteristics along with wiring diagrams. Where equipment and motor speeds are to be regulated by variable speed drives, the CONTRACTOR shall coordinate, furnish and exchange all necessary requirements with the respective equipment manufacturers to ensure compatibility and shall submit equipment, shafting, coupling, motor and variable speed drive shop drawings.
5. Bearings:
 - a. Information on bearings including but not limited to: type, size, materials of construction.
 - b. Bearing life calculations including but not limited to: basic dynamic load rating, static load rating, rating life, ABMA L10 reliability (expressed in hours of bearing life) and bearing system life.
6. Gear box design and performance criteria and AGMA service factor, including but not limited to the following:
 - a. Thermal horsepower rating
 - b. Bearing type
 - c. Actual gear ratio
 - d. Forced lubrication system: Provide description of equipment, system and instrumentation including but not limited to flow meter, pressure switches, etc.
 - e. Gear tooth finish quality
7. Piping schematics.
8. Equipment protective device details and connection diagrams.
9. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.
10. A list of spare parts and special tools to be provided.
11. Information on equipment appurtenances including couplings, shaft guards, v-belt drive systems, etc.
12. Any additional information required to demonstrate conformance with the equipment specifications.
13. Results of critical speed analyses, structural, lateral, and torsional dynamic analyses as required herein and in the individual specification sections.

14. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.
15. Shipment, delivery, handling, and storage instructions.
16. Installation instructions
17. Manufacturers literature and brochures
18. Materials of construction and associated specifications (such as AISI, ASTM, SAE, etc.), including grade and type.
19. Anchor design in accordance with Section 05 05 23 – Metal Fastening.
20. Intermediate shafting design, including but not limited to general arrangement drawings, engineering data, materials of construction, recommended angular offsets (for cardan universal jointed shafts), and shaft critical speed analyses (including 1st, 2nd and 3rd critical speed analysis).
21. Coatings: Coating system data and description of coating system, surface preparation and shop painting, including certification that the shop paint is compatible with the finish paint.
22. Pre-commissioning lubrication oil flushing plan developed by a machinery lubrication specialist, specifically for each piece of lubricated equipment. Plan shall identify, describe procedure and demonstrate data-based approach to demonstrating achievement of lubricant cleanliness via flushing. Level of lubricant cleanliness shall be as required by equipment manufacturer's written recommendations.
23. Equipment installation lists.
24. Equipment specific requirements for levelness, plumbness, flatness, coplanarity and coplanar surface deviation.

1.04 CLOSEOUT SUBMITTALS

- A. Submit warranty documentation in compliance with:
 1. Section 01 33 00 – Submittal Procedures
- B. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01 33 00 – Submittal Procedures and Section 01 78 23 Operation and Maintenance Data.

1.05 MAINTENANCE MATERIALS SUBMITTALS

- A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with:

1. Section 01 33 00 – Submittal Procedures
2. Section 01 78 23 – Operation and Maintenance Data

B. Lubrication Information:

1. Comply with Specification Section 01 78 23 – Operation and Maintenance Data.
2. Complete lubrication instructions and lubricant schedule, including manufacturer's recommended lubricant. All lubricants shall be food grade, NSF 61 approved. Schedule shall include frequency of lubricant application, type of lubricant, and instructions regarding lubricant application

1.06 QUALITY ASSURANCE SUBMITTALS

- A. Factory testing plan.
- B. Factory Test Results shall be submitted and approved prior to shipment of equipment.
- C. Field testing plan.
- D. Comply with Section 01 75 00 – Check Out and Start Up Procedures.
- E. Alignment Report:
 1. Alignment reports shall contain numerical values to express offset and angular alignment and all other parameters documented in ANSI/ASA S2.75.
 2. Alignment reports shall be submitted immediately after each of the following activities have been completed:
 - a. Preliminary Alignment
 - b. Final Alignment (at both ambient and operating temperatures)
 - c. Re-check of alignment
- F. Preliminary field test data
- G. System field quality control testing
- H. Final field test data
- I. Certified test reports

1.07 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the equipment furnished shall be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all

conditions of operation. All materials shall be new and shall conform to all applicable Sections of these Specifications.

- B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.
- C. Equipment and appurtenances shall be designed in conformity with specifications, codes and reference standards.
- D. All bearings and moving parts shall be protected by bushings or other Engineer approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.
- E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.
- F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.
- G. All machinery and equipment shall be safeguarded in accordance with the specifications, codes, and reference standards.
- H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.
- I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.
- J. All manufactured items provided under this Section shall be of current manufacture and shall be the products of manufacturers specializing in the manufacture of such products.
- K. Code Compliance, safety and ergonomics for operating and maintenance personnel accessing equipment shall be considered during shop drawing development, fabrication, and installation. Items to considering include but are not limited to clearances reserved for walking access around all sides, for opening access doors fully, for visual inspection for condition monitoring, and for the performance of maintenance tasks including but not limited to changing filters, replacing belts, maintaining lubrication levels, predictive maintenance and performing diagnostic functions.

1.08 EQUIPMENT WARRANTIES

- A. Warranty requirements shall be as specified in Section 01 75 00 – Checkout and Startup Procedures. Warranty requirements are supplementary to the individual equipment specifications.

1.09 DEFINITIONS

- A. Comply with specification Section 01 42 00 – References.
- B. Refer to the specified reference specifications, codes and standards for definitions applicable to this specification. Additional definitions are included hereafter.
- C. Chockplate: A solid steel (or alloy steel) plate with a machined top surface that is grouted to a concrete foundation to support and maintain alignment of a machinery structural steel base plate.
- D. Equipment Train: Two or more rotating equipment machinery elements consisting of at least one driver and one driven element joined together by a coupling.
- E. Mounting plate: A device used to attach equipment to concrete foundations; includes base plates, soleplates, and chockplates. A mounting plate is a base-support mechanism for the attached machinery and all individual pieces of machinery are expected to be removable from the mounting plate as a single assembly.
- F. Operating Temperature (Thermal) Alignment: A procedure to determine the actual change in relative shaft positions within a machinery train from the ambient (not running) condition and the normal operating temperature (running) condition by taking measurements from start-up to normal operating temperature while the machine(s) is (are) operating, or after the shafts have been stopped but the machines are still near operating temperature.
- G. Preliminary alignment: The aligning of two adjacent machinery shafts to ensure that final alignment can be achieved without being bolt bound. This is accomplished before grouting (for horizontal machines) and the measurement of piping strain on the machinery.
- H. Soleplate: A solid steel (or alloy steel) plate with a machined top surface that is grouted to a concrete foundation to support and maintain alignment of machinery.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All like components within a piece of equipment shall be provided by the same manufacturer.
- B. Base plates:
 - 1. Top surface of mounting plates shall be machined in locations where equipment supports/feet will contact the plate.

2. Equipment contact points shall be flat and parallel within ASA/ANSI 2.75 tolerances or 0.002-inches per foot, whichever is more stringent, and within related tolerances.
3. There shall be no paint where equipment supports or feet contact mounting plate.
4. Mounting plate shall be sufficiently rigid to avoid bending or flexing when equipment is installed.

2.02 ANCHORS AND SUPPORTS

- A. Comply with the following Specification Sections:
 1. Specification Section 05 05 23 – Metal Fastening.
 2. Comply with individual equipment specifications.
- B. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and templates shall be used by the Contractor when required in the detailed equipment Specifications.
- C. Anchor bolts and fasteners:
 1. Anchor bolts shall be designed and provided by the Contractor in accordance with Section 05 05 23 – Metal Fastening, and with the individual equipment Specifications.
 2. All anchor bolts shall have at least the minimum diameter as required by Specification Section 05 05 23 – Metal Fastening.
 3. All anchor bolts, guard bolts, washers, clips, clamps, fasteners, and leveling plate pads, nuts, shims, and jack bolts of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.
 4. Undercutting of anchors or fasteners shall not be permitted.
- D. Pipe sleeves as a means for adjusting anchor bolts shall be provided where indicated in the contract documents or required by the equipment manufacturer.
- E. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 4" high, unless otherwise shown on the Drawings, and shall be doweled.

2.03 DEFAULT MATERIALS

- A. Equipment shall be constructed out of the materials specified in respective individual pumping specification sections. Material not specifically called for shall be high-grade,

standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2.04 DISSIMILAR METALS

- A. All dissimilar metals shall be isolated in accordance with Section 05 10 00 – Metal Materials and to the satisfaction of the Engineer.

2.05 STANDARDIZATION OF GREASE FITTINGS

- A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

2.06 ELECTRICAL REQUIREMENTS

- A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit, and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 26 specifications and the latest National Electric Code. Motor starters and controls shall be furnished and installed under Division 26 and Division 40 unless otherwise specified in the individual equipment specifications.
- B. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.
- C. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between equipment supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 26 unless otherwise specified in the equipment specification. Wherever variable speed drives (VSDs) are specified the same requirements as for VFDs shall apply.
- D. Motor starters and controls shall be furnished and installed under Division 26 and Division 40 unless otherwise specified in the individual equipment specifications.

2.07 EQUIPMENT IDENTIFICATION

- A. All mechanical equipment shall be provided with a substantial stainless-steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with:
 - 1. The manufacturer's name
 - 2. Year of manufacture
 - 3. Serial number
 - 4. Principal rating data such as (for example):

- a. Capacity
 - b. Pressure
 - c. Horsepower
 - d. Speed
- B. Each piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless-steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1 (RWP-1)". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.
- C. Nameplates shall not be painted over.

PART 3 – EXECUTION

3.01 SHOP TESTING

- A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.
- B. No equipment shall be shipped to the project site until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.
- C. A certified copy of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Engineer for review.
- D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Owner.
- E. Shop testing of electric motors shall conform to:
 - 1. Section 26 05 60 – Low-Voltage Electric Motors
 - 2. Section 26 05 00 – Basic Electrical Requirements

3.02 SHIPMENT, DELIVERY, HANDLING AND STORAGE

- A. Shipping plans shall include consideration for protecting bearings and/or other rotating equipment from chatter damage.

- B. Any equipment shipped to site that needs further attention shall have a WARNING tag affixed to it with indication of the action that should be taken in preparation for startup. Examples are: Final Lubrication, Mechanical Seal not in final position, etc.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer's field services shall be in accordance with Section 01 75 00 – Checkout and Startup Procedures.
- B. The Contractor shall arrange for a qualified factory trained Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Engineer and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Contractor shall schedule multiple Technical Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.
- C. Services of the Technical Representative will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Engineer but will not be less than the number of days specified in individual equipment sections. Additional site visits may be required as described below and in the equipment specifications.
- D. For each site visit, the Technical Representative shall submit jointly to the Owner, the Engineer, and the Contractor a complete signed report of the results of their inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.
- E. The manufacturer's Technical Representative shall provide the following services.
 - 1. Installation: The Technical Representative shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Technical Representative shall also supervise the installation of the equipment.
 - 2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Technical Representative shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall

include date of final acceptance field test, as well as a listing of all persons present during tests.

3. **Startup:** The Technical Representative shall start up the equipment for actual service with the help of the Contractor. If equipment or installation problems are experienced, the Contractor and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.
 4. **Services after Startup:** Where required by the individual equipment specifications, the Technical Representative shall return to the project site thirty (30) days after the startup date to review the equipment performance, correct any equipment problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Technical Representative prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that their equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Technical Representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.
- F. The Contract amount shall include the cost of furnishing the Technical Representative for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Technical Representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.
- G. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.
- H. The Technical Representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day the Technical Representative is at the project.

3.04 INSTALLATION

- A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished to the Engineer's field representative one week prior to installation.

- B. The Owner's field representative (e.g., the Engineer or similar) shall witness all activities involved with equipment installation.
- C. The Contractor shall have on hand personnel, construction equipment, and machinery of capacity to facilitate the work and to handle all emergencies encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled insofar as practical.
- D. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.
- E. All equipment sections and loose items shall be match-marked prior to shipping.
- F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.
- G. Leveling and Grouting:
 - 1. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to +/- 1/16 inch except as otherwise specified, required or indicated on the drawings.
 - 2. Base plate Surface Preparation – Prior to setting equipment and grouting, inspect and clean equipment mounting base plates, pads, feet, and frames to remove all grease, rust, paint, and dirt.
 - 3. Wedges (i.e., tapered shims) shall not be used for leveling, aligning, or supporting equipment.
 - 4. General Equipment Leveling:
 - a. Non-rotating Equipment: Set level to +/- 1/16 inch per 10-foot length (0.005 inch per foot) unless manufacturer's requirements are more stringent.
 - b. Rotating Equipment: Install, set to the most stringent of the following requirements for levelness, plumbness, flatness, coplanarity and coplanar surface deviation:
 - 1) ASA-ANSI S2.75, Shaft Alignment Methodology. Comply with tolerance ranges scheduled at the end of this specification section.
 - 2) Individual equipment specifications
 - 3) Manufacturer's pre-printed written requirements.
 - 4) When the equipment manufacturer's pre-printed tolerances are more stringent than those stated in ASA/ANSI 2.75 or more stringent than the individual pump specification, the cost of field machining sole plates or precision grouting sole plates shall be covered by the

[Contractor] [by the allowance stated in the bid table] [by the unit cost stated in the bid table].

- c. Shims or leveling nuts shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment base plate edges. When grouting is required, equipment shall be shimmed to allow a minimum of one-inch grout thickness. Grout shall cover shims at least 3 inches. Final level check shall be held for inspection and approval by Engineer before proceeding.
- d. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with epoxy base plate grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (e.g., such as shim leveling pumps, or chemical grout).

5. Grouting

- a. Comply with Section 03 60 00 – Grout.
- b. Grout Materials:
 - 1) Rotating Equipment: Grout for rotating equipment shall be epoxy base plate grout. Cementitious grouts shall not be accepted for rotating equipment.
 - 2) Non-rotating Equipment: Grout shall be as per the non-rotating equipment manufacturer's pre-printed written installation instructions and shall be subject to the Engineer's approval.
- c. Fill pipe sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.
- d. Concrete Surface Preparation: Roughen concrete equipment pad surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale.
 - 1) When grouting with cementitious grouts is approved, the contact area of the concrete equipment pad shall be saturated with water at least 4 hours prior to grouting, removing excess water ponds.
- e. Application:
 - 1) Place grout after the equipment base has been set and its initial alignment and level have been approved.
 - 2) Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions.

- 3) Grout mixture shall be flowable. Dry packing of grout shall not be permitted.
 - 4) Eliminate all air or water pockets beneath the base using a drag chain or rope.
 - 5) Grout voids detectable by tapping the top of the base plate with a hammer shall be grounds for removal and reinstallation of the work.
- f. Finishing: Point the edges of the grout to form a smooth 45-degree slope.
 - g. After cementitious grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.
 - h. Level Verification. After grout has cured, and immediately prior to final drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.
6. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.

3.05 ALIGNMENT

- A. For equipment that requires field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the equipment and motor prior to making piping connections or anchoring the equipment base. Alignment shall be as specified herein.
- B. Rotating Equipment Shaft Alignment: Assembled equipment shafts shall be set to comply with the most stringent of the following tolerance requirements for shaft runout and shaft-to-shaft alignment tolerances expressed in angle at flex plane, in offset and angularity and/or in offset per tolerance plane separation:
 1. ASA-ANSI S2.75, Shaft Alignment Methodology. Comply with tolerance ranges scheduled at the end of this specification section.
 2. Individual equipment specifications
 3. Manufacturer's pre-printed written requirements.
- C. Use the machined surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.
- D. Sprocket and Sheave Alignment:
 1. Check shaft mounted components for face runout and eccentricity (outside diameter) runout by magnetically mounting a dial indicator on a stationary base and indicating over 360 degrees on a continuous machined surface at the outside

diameter of the component. Maximum allowable total indicated face runout and eccentricity for sprockets and sheaves will be per ANSI Standard B29.1-1975.

2. Drive and driven sheaves shall lie in the same plane. The sum of parallel and angular sheave misalignment measured across the span length of the belt and angular misalignment perpendicular to the belt span length shall each not exceed $\frac{1}{2}$ degree or the belt manufacturer's recommendation whichever is more stringent.
- E. Belt tensioning: Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.
- F. Thermal/Mechanical Growth: Thermal/mechanical growth corrections for driver and driven machines will be used in vertical and horizontal alignment where applicable. The equipment manufacturer will determine thermal/mechanical growth applicability for any machine and provide the correction offsets to be used.
- G. Rotating Shaft Alignment
1. Measurement devices/fixtures will be set up on the driver and driven machine, or machine shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.
 2. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.
 3. Final alignments shall be performed utilizing laser alignment tools unless otherwise approved by the Engineer.
 4. Cardan Universal Jointed Intermediate Shafting:
 - a. Align cardan universal joints in accordance with manufacturer's written offset recommendations.
 - b. Offsets shall be field verified.
 - c. Contractor shall have unit responsibility for all components of extended shaft driven equipment, including but not limited to the coordination of shaft design with equipment, variable frequency drive and control strategies.
 5. Alignment Steps: Each of the following alignment steps are required in all instances, including but not limited to, all vertically and horizontally mounted drivers:
 - a. Preliminary alignment is when uncoupled. Preliminary Alignment (at ambient temperature):
 - 1) Perform prior to grouting and piping connections.
 - 2) Check shaft straightness (runout).

- 3) Correct for soft foot.
 - b. Final alignment method is when coupled. Final Alignment (at ambient temperature):
 - 1) Perform after grouting and piping connections have been completed.
 - 2) Check for pipe strain.
 - 3) Alignment shall be within tolerances.
 - c. Final alignment method is when coupled. Final Alignment (at operating temperature after 1-hour of continuous operation):
 - 1) Check for pipe strain.
 - 2) Alignment shall be within tolerances (coupled).
 - d. Re-check alignment (at operating temperature):
 - 1) After a minimum of 24-hours of run time
 - 2) Alignment shall be within tolerances (coupled)
6. Additional Alignment Steps for Vertical Mixers:
 - a. Level gearbox.
 - b. Verify vertical plumbness of shaft (while shaft is not turning).
 - c. Grout.
 - d. Check shaft runout.
 - e. Install impeller blades.

3.06 FIELD TESTING

- A. Field testing shall be in accordance with Section 01 75 00 – Checkout and Startup Procedures.
- B. All equipment shall be set, aligned, and assembled in conformance with the manufacturer's drawings and instructions. Provide all necessary calibrated instruments to execute performance tests. Submit report certified by the pump manufacturer's representative.
- C. Preliminary Field Tests, Yellow Tag.

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall:
 - a. Verify that the equipment is free from defects.
 - b. Check for alignment as specified herein.
 - c. Check for direction of rotation.
 - d. Check motor for no load current draw.
2. Contractor shall flush all bearings, gear housings, etc., in accordance with the pre-commissioning lubrication oil flushing plan and manufacturer's pre-printed written recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.
3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or the Engineer's assigned representative and attached to the equipment. The tag shall not be removed.
4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

D. Final Field Tests, Blue Tag

1. Upon completion of the above, and at a time approved by the Engineer, the equipment will be tested by operating it as a unit with all related piping, ducting, electrical and controls, and other ancillary facilities.
2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or the Engineer's assigned representative and the Owner or the Owner's assigned representative.
3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Operating field tests shall consist of the following:
 - a. Check equipment for excessive vibration and noise.
 - b. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded. The rated motor nameplate horsepower shall not be exceeded when a torque transducer is provided.
 - c. Recheck alignment where applicable, after unit has run under load for a minimum of 24 hours.

- E. Additional field testing recommended by the manufacturer shall be performed at no cost to Owner.
- F. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments, and replacements at no additional cost to the Owner.
- G. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed, and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.
- H. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.
- I. All costs in connection with field testing of equipment such as lubricants, temporary instruments, labor, equipment, etc., shall be borne by the Contractor. Power, fuel, chemicals, water, etc. normally consumed by specific equipment shall be supplied by the Owner unless otherwise specified in the individual equipment specifications.
- J. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.
- K. Field testing of electric motors shall be in accordance with Section 26 05 60 – Low-Voltage Electric Motors, and Section 26 05 00, Basic Electrical Requirements.

3.07 VIBRATION TESTING

- A. Vibration testing shall be in accordance with Section 01 75 00 – Checkout and Startup Procedures.

3.08 FAILURE OF EQUIPMENT TO PERFORM

- A. Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements or otherwise.
- B. If the Contractor fails to make these corrections, or if the improved equipment shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding their having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.
- C. The Contractor shall then obtain specified equipment to meet the contract requirements or upon mutual agreement with the Owner, adjust the contract price to reflect not supplying the specific equipment item.

- D. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified.
- E. Upon receipt of said sums of money, the Owner will execute and deliver to the Contractor a bill of sale of all rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected.
- F. Said bill of sale shall not abrogate Owner's right to recover damages for delays, losses, or other conditions arising out of the basic contract.

3.09 WELDING

- A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- B. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.
- C. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

END OF SECTION

Schedule 46 00 00 – 01 – Applicable Tolerance Range

Equipment Horsepower	ANSI/ASA S2.75 Quality Grade Tolerance Range
≤ 25 HP	Minimal
> 25 HP < 100 HP	Standard
≥ 100 HP	Precision

Scheduled ANSI/ASA S2.75 Quality grade tolerance range categories relate to ANSI/ASA S2.75 quantified tolerances for: levelness, plumbness, flatness, coplanarity, coplanar surface deviation, shaft runout, shaft-to-shaft alignment, flex plane offset, angularity, and offset per tolerance plane separation.

SECTION 46 41 42
CHEMICAL INJECTION ASSEMBLIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, adjust, and place in satisfactory operation chemical injection assemblies as shown on the Drawings and as specified herein.
- B. Equipment shall be provided in accordance with the requirements of Section 46 00 00 - Equipment General Provisions, and Division 40 – Process Interconnections.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Chemical Injection Assemblies

Service	Chlorine Gas
No. of Assemblies	1
Type of Feed Device	Injector
Maximum Concentration	5%
Chemical Pipe Diameter	1"
Chemical Pipe Material	CPVC
Maximum Chemical Feed Rate	20 gph
Max Chemical Discharge Pressure	50 psi
Receiving Pipe Diameter	12"
Receiving Pipe Material	Ductile Iron
Maximum Receiving Pipe Pressure	15 psi
Maximum Receiving Pipe Velocity	5 fps
Application Point	Filter Effluent

1.03 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to, the submittal requirements specified in Section 01 33 00 – Submittal Procedures, and Section 46 00 00 – Equipment General Provisions:
 - 1. Equipment specifications and data sheets, with identification of all materials of construction.
 - 2. Complete assembly, layout, installation and shop drawings, with clearly marked dimensions, tolerances, jointing and anchoring details.

3. Weights of equipment component parts.
4. Chemical resistance data for wetted parts.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The chemical injection assemblies shall be as manufactured by SAF-T-FLO Water Services, Inc., or approved equal.

2.02 CONSTRUCTION AND MATERIALS

- A. Each injection assembly shall be specifically designed for the particular chemical service for which it is being supplied. The materials of construction for the assemblies shall be compatible with the chemicals being fed and shall be suitable for the pressure in the chemical solution line and receiving pipe, the maximum velocity in the receiving pipe, and the insertion length.
- B. Chemical injection assembly components that come into contact with the chemical shall be constructed of materials that meet NSF-61 certification standards.
- C. Acceptable injection assembly construction shall be as follows:

Standard Service Quill	Sodium Hypochlorite
Injection Quill:	
Isolation Valve	Threaded CPVC
Tube	CPVC
Tip Configuration	Standard or 45° Bevel
Check Valve Material	CPVC
Check Valve Seal	FKM
Flexible Tubing Assembly:	
Valve	CPVC
Seal	FKM
Tubing	Reinforced PVC
End Connection	[MNPT Outlet

- D. The injection assemblies shall be retractable and furnished with an isolation assembly, solution tube assembly including check valve, locking device, and safety chains. The

locking device shall connect the solution tube to the corporation stop on the receiving pipe to prevent accidental withdrawal of the solution tube. A stainless steel safety chain shall prevent the solution tube from being withdrawn past the compression ring in the gland. Safety chain length shall be determined by the manufacturer based on solution tube length.

- E. The assemblies shall be sized to match the pump discharge line or injection flow rate and shall be of the same diameter as the chemical piping. The injection assembly solution tubes shall penetrate into the pipe a distance equivalent to a minimum of 1/3 of the pipe diameter into which the chemicals are being injected.
- F. Each injector shall be furnished with a flexible hose assembly consisting of flexible hose/tubing, connection fittings, seals and ball valve, specifically designed for the particular chemical service for which it is being supplied. Flexible hose assembly shall also be capable of withstanding maximum pump discharge line pressure.

PART 3 – EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

- A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 46 00 00 – Equipment General Provisions.

Service	Number of Trips	Number of Days/Trip
Installation, Testing, and Training	1	1

3.02 INSTALLATION

- A. The Contractor shall furnish the chemical injectors and all associated equipment and accessories as required and specified herein in accordance with the manufacturer's instructions and in accordance with Section 46 00 00 – Equipment General Provisions.

END OF SECTION

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