



Invitation for Bid No. 2021-036
SP105 Crooked Creek WRF Process Improvements

Due Date: January 28, 2021

Time: 2:00 PM EST

Receipt Location: Union County Government Center
Procurement Department
500 N. Main Street, Suite 709
Monroe, NC, 28112-4730

Procurement Representative:

Vicky Watts, CLGPO
Senior Procurement Specialist
(704) 283-3601
vicky.watts@unioncountync.gov

Prepared by:

Hazen and Sawyer
9101 Southern Pine Blvd. Suite 250
Charlotte, NC 28273
(704) 357-3150
NC License No. C-0381



SP105 Crooked Creek WRF Process Improvements

Bid Set



Hazen

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**UNION COUNTY
UNION COUNTY, NORTH CAROLINA
SP105 CROOKED CREEK WRF PROCESS IMPROVEMENTS
IFB # 2021-036**

ADVERTISEMENT FOR BIDS

Sealed Bids for the construction of project **SP105 Crooked Creek WRF Process Improvements** will be received by Union County Procurement Department, Union County Government Center, at 500 N. Main Street, Suite 709, Monroe, North Carolina 28112, until **2:00 PM** local time on ***January 28, 2021** at which time the Bids received will be **publicly** opened and read. ***If you plan to attend the bid opening, masks and social distancing rules apply.***

*On **January 28, 2021**, beginning at **1:30 PM** local time, bids will be received by the Union County Procurement Department at the bid opening location of Union County Government Center, 500 North Main Street, 1st Floor, Board of County Commissioners Chambers, Monroe, NC 28112.

The Work to be performed under this Contract generally includes, but is not limited to, constructing the Work described below and all appurtenances related to the Work. The Work shall be as follows: Replacement of existing brush aerators in the Oxidation Tanks with new rotary disc aerators and VFDs; New Scum Pump Stations No. 1 & 2, including submersible chopper pumps, valve vaults, and a 4" Scum force main discharging to Digesters No. 1 & 2 and the Drying Beds; Replacement / relocation of the scum troughs in the Secondary Clarifiers; New Sludge Flow Control Vaults No. 1 – 4, including flow meters and modulating plug valve for controlling flow to the Return Sludge Pump Station; Piping modifications in the Secondary Clarifiers to allow for connection to these new vaults; New Electrical Canopy (MCC-RAS), to provide power and control equipment / connections to the new facilities as well as some existing facilities; VFDs for the disc aerators; New PLC-RAS; All other discipline work shown on the drawings.

A Pre Bid Meeting (Non-Mandatory) will be held at the Crooked Creek Water Reclamation Facility (4015 Sardis Church Road; Monroe, NC 28110) on Thursday, January 14, 2021 at 2:00 PM. Attendance is strongly encouraged.

Bids will be received for a single prime Contract. Bids shall be on a lump sum basis as indicated in the Bid Form.

All questions about the meaning or intent of the Bidding Documents are to be submitted, in writing, to the Procurement contact person listed on the cover page (vicky.watts@unioncountync.gov). Deadline for questions is 5:00 PM local time on Monday, January 18, 2021.

The Issuing Office for the Bidding Documents is: Hazen and Sawyer, 9101 Southern Pine Blvd, Suite 250, Charlotte, NC 28273.

Prospective Bidders may examine the Bidding Documents at the Issuing Office or at the Union County Procurement Department offices at 500 North Main Street, 7th Floor, Suite 709, Monroe, North Carolina 28112 on Mondays through Fridays between the hours of 8:00 am and 5:00 pm, and may obtain copies of the Bidding Documents from the Issuing Office as described below.

Bidding Documents may be ordered from Hazen and Sawyer by contacting Lisa Thomas at lthomas@hazenandsawyer.com or 704-357-3150.

Printed copies of the Bidding Documents may be obtained from the Issuing Office upon payment of **\$100.00** (non-refundable) for each set. Checks for Bidding Documents shall be payable to **Hazen and Sawyer**. Cost of Bidding Documents includes ground shipping.

If Bidding Documents are required to be shipped overnight, Bidder shall provide a six-digit UPS account number. The date that the Bidding Documents are transmitted by the Issuing Office will be considered the Bidder's date of receipt of the Bidding Documents. Partial sets of Bidding Documents will not be available from the Issuing Office.

Bidders must have a license to do work as a general contractor in the State of North Carolina, as set forth under Article 1 of Chapter 87 of the North Carolina General Statutes. The Contractor's North Carolina License number shall be designated on the outside of the envelope containing the bid.

Bidders are required to comply with the non-collusion requirements set forth in the Bidding Documents.

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

Union County (Owner) reserves the right to reject any or all bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner further reserve the right to reject the Bid and Bidder whom they find, after reasonable inquiry and evaluation, to not be responsible. Owner may also reject the Bid and Bidder if the Owner believes that it would not be in the best interest of the Project to make an award to that Bidder. Owner also reserves the right to waive all informalities and technicalities not involving price, time, or changes in the Work and to negotiate, as allowed by law, contract terms with the Successful Bidder.

Good Faith effort outreach to Minority Businesses (HUB Certified) and Small Businesses shall be documented in accordance with the Instructions to Bidders. Bidders should note the provisions of the instructions to Bidders contained in the Bid Documents regarding HUB/minority participation. Bidders shall submit a completed identification of HUB Certified/Minority Participation form and with Affidavit A or Affidavit B as Applicable, along with their bid.

++END OF ADVERTISEMENT FOR BIDS++

INSTRUCTIONS TO BIDDERS

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ARTICLE 1 – DEFINED TERMS

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

A. *Issuing Office* – The office from which the Bidding Documents are to be issued.

ARTICLE 2 – COPIES OF BIDDING DOCUMENTS

2.01 Complete sets of the Bidding Documents may be obtained from the Issuing Office in the number and format stated in the advertisement or invitation to bid.

2.02 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.

2.03 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 authorize or confer a license for any other use.

ARTICLE 3 – QUALIFICATIONS OF BIDDERS

3.01 To demonstrate Bidder's qualifications to perform the Work, Bidder shall submit with its Bid (a) written evidence establishing its qualifications such as financial data, previous experience, and present commitments, and (b) the following additional information:

A. Evidence of Bidder's authority to do business in the state where the Project is located.

B. Bidder's state or other contractor license number, if applicable.

C. Subcontractor and Supplier qualification information; coordinate with provisions of Article 12 of these Instructions, "Subcontractors, Suppliers, and Others."

3.02 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contract.

3.03 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

3.04 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

ARTICLE 4 – SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

4.01 *Site and Other Areas*

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

4.02 *Existing Site Conditions*

A. Subsurface and Physical Conditions; Hazardous Environmental Conditions

1. The Supplementary Conditions identify:
 - a. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site.
 - b. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).
 - c. reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.
 - d. Technical Data contained in such reports and drawings.
2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply

- B. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site are set forth in the Contract Documents and are based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.
- C. Adequacy of Data: 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 unanticipated subsurface or physical conditions appear in Paragraphs 4.02, 4.03, and 4.04 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.

4.03 *Site Visit and Testing by Bidders*

- A. Bidder shall conduct the required Site visit during normal working hours, and shall not disturb any ongoing operations at the Site.
- B. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

- C. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site.
- D. Bidder shall comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.
- E. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.04 *Owner's Safety Program*

- A. Site visits and work at the Site may be governed by an Owner safety program. As the General Conditions indicate, if an Owner safety program exists, it will be noted in the Supplementary Conditions.

4.05 *Other Work at the Site*

- A. Reference is made to Article 7 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 5 – BIDDER'S REPRESENTATIONS

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

- A. examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;
- B. visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;
- C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;
- D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings;

- E. consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the 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; and (3) Bidder's safety precautions and programs;
- F. agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;
- G. become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;
- H. promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder;
- I. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and
- J. agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 6 – PRE-BID CONFERENCE

- 6.01 A pre-Bid conference will be held at the time and location stated in the invitation or advertisement to bid. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference.
- 6.02 Addenda may be issued to clarify, supplement, or change the Bidding Documents. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 – INTERPRETATIONS AND ADDENDA

- 7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to the to the Procurement contact person listed on the cover page, vicky.watts@unioncountync.gov, in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all parties recorded as having received the Bidding Documents. Questions received after 5:00 pm on January 18, 2020 may not be answered. Only questions answered by Addenda will be binding. All such changes or interpretations will be made in writing in the form of Addenda, and, if issued, will be mailed or sent by available means to all known prospective bidders not later than seventy two (72) hours prior to the established bid opening date time. Oral and other interpretations or clarifications will be without legal effect.
- 7.02 Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents.

ARTICLE 8 – BID SECURITY

- 8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of [5%] percent of Bidder’s maximum Bid price (determined by adding the base bid and all alternates) and in the form of a certified check, bank money order, or a Bid bond (on the form included in the Bidding Documents) issued by a surety meeting the requirements of Paragraphs 5.01 and 5.02 of the General Conditions.
- 8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within ten (10) days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited.
- 8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Contract or one (1) day more than the period for which Bids are subject to acceptance, whereupon Bid security furnished by such Bidders will be released.
- 8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within seven days after the Bid opening.

ARTICLE 9 – CONTRACT TIMES

- 9.01 The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 – LIQUIDATED DAMAGES

- 10.01 Provisions for liquidated damages, if any, are set forth in the Agreement.

ARTICLE 11 – SUBSTITUTE AND “OR-EQUAL” ITEMS

- 11.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, and those “or-equal” or substitute or materials and equipment subsequently approved by Engineer prior to the submittal of Bids and identified by Addendum. No item of material or equipment will be considered by Engineer as an “or-equal” or substitute unless written request for approval has been submitted by Bidder and has been received by Engineer at least 15 days prior to the date for receipt of Bids. Each such request shall comply with the requirements of Paragraph 6.05 of the General Conditions. The burden of proof of the merit of the proposed item is upon Bidder. Engineer’s decision of approval or disapproval of a proposed item will be final. If Engineer approves any such proposed item, such approval will be set forth in an Addendum issued to all prospective Bidders. Bidders shall not rely upon approvals made in any other manner.

It is the intent of the Contract Documents to comply with N.C.G.S. §133-3 and to encourage free and open competition on public contracts. However, nothing in this Subparagraph is intended to permit bidders to submit proposals for the use of products or materials which have not been approved by Engineer prior to the receipt of bids as provided by N.C.G.S. §133-3. All submittals for substitution approval shall be made in accordance with the provisions of these Instructions to Bidders:

.1 Wherever the Specifications list only required performance and design characteristics for a product or material, bidders wishing to provide such a product or material shall submit such for approval.

.2 Where the Specifications list three or more names of products or materials, the listed examples are used only to denote the quality standard of product desired and do not restrict bidders to a specific brand, make, manufacturer or specific name. Rather, they are used only to set forth and convey to bidders the general style, type, character and quality of product desired. Products of similar general style, type, character appearance, and quality may be submitted for approval.

.3 Where the Specifications list fewer than three names of product or material, such products are the only products known to Engineer that comply with the required style, type, character appearance, and quality necessary for this product. Bidders wishing to propose equivalent products may do so.

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

ARTICLE 12 – SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 In addition to any identification of Subcontractors, Suppliers, individuals, or entities required to be submitted to Owner by the Supplementary Conditions (see third full paragraph below), Bidders shall include in their Bid a list of all subcontractors which the Bidder intends to use.

A contractor whose Bid is accepted shall not substitute any person as subcontractor in the place of the subcontractor listed in the original bid, except (i) if the listed subcontractor's bid is later determined by the contractor to be nonresponsive or nonresponsive or the listed subcontractor refuses to enter into a contract for the complete performance of the bid work, or (ii) with the approval of the awarding authority for good cause shown by the contractor. The terms, conditions, and requirements of each contract between Contractor and a subcontractor performing work under a subdivision or branch of work listed in this subsection shall incorporate by reference the terms, conditions, and requirements of the Contract between Contractor and Owner. Failure to include this list of subcontractors may cause a Bid to be rejected as nonresponsive by Owner.

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 days after Bid opening, submit to Owner a list of all such Subcontractors, Suppliers, individuals, or 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 qualification for each such Subcontractor, Supplier, individual, or 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 apparent Successful Bidder to submit a substitute, without an increase in the Bid.

- 12.02 Subsequent to the submittal of the Bid, Owner may not require the Successful Bidder or Contractor to retain any Subcontractor, Supplier, or other individual or entity against which Contractor has reasonable objection.

ARTICLE 13 – PREPARATION OF BID

- 13.01 The Bid Form is included with the Bidding Documents.
- A. All blanks on the Bid Form shall be completed in ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form.
- B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words “No Bid” or “Not Applicable.”
- 13.02 A Bid by a corporation shall be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation shall be shown. The corporate seal shall be affixed and attested by the corporate secretary or an assistant corporate secretary.
- 13.03 A Bid by a limited liability company shall be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.
- 13.04 A Bid by an individual shall show the Bidder’s name and official address.
- 13.05 A Bid by a joint venture shall be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.
- 13.06 All names shall be printed in ink below the signatures.
- 13.07 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.
- 13.08 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.
- 13.09 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 covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder’s state contractor license number, if any, shall also be shown on the Bid Form.

ARTICLE 14 – BASIS OF BID

14.01 *Lump Sum*

Bidders shall submit a Bid on a lump sum and unit price basis, with a pre-negotiated bid item as set forth in the Bid Form.

14.02 *Unit Price*

- A. Bidders shall submit a Bid on a unit price basis for each item of Work listed in the unit price section of the Bid Form.
- B. The “Bid Price” (sometimes referred to as the extended price) for each unit price Bid item will be the product of the “Estimated Quantity” (which Owner or its representative has set forth in the Bid Form) for the item and the corresponding “Bid Unit Price” offered by the

Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total will be used by Owner for Bid comparison purposes. The final quantities and Contract Price will be determined in accordance with Paragraph 11.03 of the General Conditions.

- C. 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.

14.03 Allowances

- A. For cash allowances the Bid price shall include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 11.02.B of the General Conditions.

ARTICLE 15 – SUBMITTAL OF BID

15.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 7 of the Bid Form.

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

Union County Procurement Department

Attention: Vicky Watts

500 N. Main Street Suite 709

Monroe, NC 28112

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

ARTICLE 16 – MODIFICATION AND WITHDRAWAL OF BID

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

16.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 16.01 and submit a new Bid prior to the date and time for the opening of Bids.

16.03 A bid may be modified or withdrawn under the conditions set forth in N.C.G.S §143-129.1. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

ARTICLE 17 – OPENING OF BIDS

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

ARTICLE 18 – BIDS TO REMAIN SUBJECT TO ACCEPTANCE

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

ARTICLE 19 – EVALUATION OF BIDS AND AWARD OF CONTRACT

19.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the Owner will reject the Bid as nonresponsive; provided that Owner also reserves the right to waive all minor informalities not involving price, time, or changes in the Work.

19.02 If Owner awards the contract for the Work, such award shall be to the responsible Bidder submitting the lowest responsive Bid. Award of a bid by the Owner's governing body represents a preliminary determination as to the qualification of the Bidder, but the Bidder understands and agrees that no legally binding acceptance of Bidder's offer occurs until the Owner's governing body, or its designee, executes a formal contract with the Bidder.

19.03 Evaluation of Bids

A. In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

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

19.04 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

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

ARTICLE 20 – BONDS AND INSURANCE

20.01 Article 5 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the Agreement (executed by Successful Bidder) to Owner, it shall be accompanied by required bonds and insurance documentation.

ARTICLE 21 – SIGNING OF AGREEMENT

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

ARTICLE 22 – UNION COUNTY MINORITY AND SMALL BUSINESS GUIDELINES AND OUTREACH PLAN

[Refer to document following this section.]

UNION COUNTY
MINORITY AND SMALL BUSINESS GUIDELINES AND
OUTREACH PLAN



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GUIDELINES FOR RECRUITMENT AND SELECTION OF MINORITY BUSINESSES FOR PARTICIPATION IN UNION COUNTY CONSTRUCTION CONTRACTS

In accordance with G.S. §143-128.2, these Guidelines establish goals for minority participation in single-prime bidding, separate-prime bidding, construction manager at risk, and alternative contracting methods on County building construction, erection, alteration, and repair projects (“building projects”) in the amount of \$300,000 or more and on County building projects involving State funding where the total project cost \$100,000 or more.

Union County has established a verifiable goal of 10% for participation by minority businesses in the aforementioned building project contracts. The overall goal will be reviewed annually or as soon as relevant data is available.

SECTION A: INTENT

It is the intent of these Guidelines that Union County, as awarding authority for building projects, and the contractors and subcontractors performing the building project contracts awarded, shall cooperate and in good faith do all things legal, proper and reasonable to achieve the goal of ten percent (10%) for participation by minority businesses in each construction project as mandated by G.S. §143-128.2. Nothing in these Guidelines shall be construed to require contractors or awarding authorities to award contracts or subcontracts to or to make purchases of materials or equipment from minority-business contractors or minority-business subcontractors who do not submit the lowest responsible, responsive bid or bids.

A copy of these Guidelines will be issued with each bid package for applicable Union County building projects. These Guidelines shall apply to all contractors on such projects, regardless of ownership.

SECTION B: DEFINITIONS

1. Minority - a person who is a citizen or lawful permanent resident of the United States and who is:
 - a. Black, that is, a person having origins in any of the black racial groups in Africa;
 - b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
 - c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, the Pacific Islands;
 - d. American Indian, that is, a person having origins in any of the original Indian peoples of North America; or
 - e. Female

2. Minority Business - means a business that meets all of the following conditions:
 - a. At least fifty-one percent (51%) of the business is owned by one or more minority persons or socially and economically disadvantaged individuals, or in the case of a corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and
 - b. The management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it; and
 - c. The business is certified as a Historically Underutilized Business by the North Carolina Department of Administration Office for Historically Underutilized Business.

3. Socially and economically disadvantaged individual - means the same as defined in 15 U.S.C. 637. “Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities.” “Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged.”

4. Public Entity - means the State and all public subdivisions and local governmental units.

5. Owner - Union County.

6. Designer - Any person, firm, partnership, or corporation, which has contracted with the Owner to perform architectural or engineering work.

7. Bidder - Any person, firm, partnership, corporation, association, or joint venture seeking to be awarded a public contract or subcontract.

8. Contract - A mutually binding legal relationship or any modification thereof obligating the seller to furnish equipment, materials or services, including construction, and obligating the buyer to pay for them.

9. Contractor - Any person, firm, partnership, corporation, association, or joint venture which has contracted with the Owner to perform building construction, erection, alteration, or repair work.

10. Subcontractor - A firm under contract with the prime contractor or construction manager at risk for supplying materials or labor and materials and/or installation. The subcontractor may or may not provide materials in his subcontract.

11. HUB Office – N.C. Department of Administration’s Office for Historically Underutilized Businesses.

SECTION C: RESPONSIBILITIES

1. Owner:

The Owner shall do the following:

- a. Implement the attached “Union County’s Minority and Small Business Participation Outreach Plan” to identify minority businesses that can perform public building projects and to implement outreach efforts to encourage minority business participation in these projects to include education, recruitment, and interaction between minority businesses and nonminority businesses.
- b. Attend the scheduled prebid conference and explain the minority goals and objectives.
- c. At least 10 days prior to the scheduled day of bid opening, notify minority businesses that have requested notices from the Owner for public construction or repair work and minority businesses that otherwise indicated to the Office of Historically Underutilized Businesses an interest in the type of work being bid or the potential contracting opportunities listed in the proposal. The notification shall include the following:
 - (1) A description of the work for which the bid is being solicited.
 - (2) The date, time, and location where bids are to be submitted.
 - (3) The name of the individual within the public entity who will be available to answer questions about the project.
 - (4) Where bid documents may be reviewed.
 - (5) Any special requirements that may exist.
- d. Utilize other media, as appropriate, likely to inform potential minority businesses of the bid being sought.
- e. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
- f. Review, jointly with the designer, all requirements of G.S. 143-128.2(c) and G.S. 143-128.2(f) prior to recommendation of award.
- g. Evaluate documentation to determine that a good faith effort has been achieved for minority business utilization prior to recommendation of award.
- h. Forward documentation showing evidence of implementation of Owner’s requirements to the State Construction Office and the HUB Office upon

request.

In addition, after a contract has been awarded the Owner shall:

- a. Review prime contractors' pay applications for compliance with minority business utilization commitments prior to payment.
- b. Submit the report to the HUB Office as required by G.S. 143-128.3(a).

2. Designer:

Under the single-prime bidding, separate prime bidding, dual bidding, construction manager at risk, or alternative contracting method, the Designer must do all of the following:

- a. Attend the scheduled pre-bid conference to explain minority business requirements to the prospective bidders.
- b. Assist the Owner to identify and notify prospective minority business prime and subcontractors of potential contracting opportunities and provide documentation of this assistance for the Owner's records.
- c. Maintain documentation of any contacts, correspondence, or conversations with minority business firms made in an attempt to meet the goals and forward the documentation to the Owner.
- d. Review jointly with the Owner, all requirements of G.S. §143-128.2(c) and G.S. § 143-128-2(f) - (i.e. bidders' proposals for identification of the minority businesses that will be utilized with corresponding total dollar value of the bid and affidavit listing Good Faith Efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of an award.
- e. During construction phase of the project, review "MBE Documentation for Contract Payment" - (Appendix E) for compliance with minority business utilization commitments. Submit Appendix E form with monthly pay applications to the Owner.
- f. Make documentation showing evidence of implementation of Designer's responsibilities available for review by the Owner and State officials upon request.

3. Prime Contractor(s), Construction Manager at Risk, and Its First-Tier Subcontractors:

The following requirements apply to all contractors utilizing single-prime bidding, separate-prime bidding, construction manager at risk and alternative contracting methods, as well as to all contractors performing as contractors and first-tier subcontractors under construction manager at risk. For purposes of this subsection, the term "contractor(s)"

shall also include first-tier subcontractors under a construction manager at risk. The contractors shall:

- a. Attend the scheduled prebid conference and any prebid meetings scheduled by the Owner.
- b. Identify or determine those work areas of a subcontract where minority businesses may have an interest in performing subcontract work.
- c. At least ten (10) days prior to the scheduled day of bid opening or due date for proposals, notify minority businesses of potential subcontracting opportunities listed in the proposal. The notification must include all of the following:
 - (1) A description of the work for which the subbid is being solicited.
 - (2) The date, time and location where subbids are to be submitted.
 - (3) The name of the individual within the company who will be available to answer questions about the project.
 - (4) Where bid documents may be reviewed.
 - (5) Any special requirements that may exist, such as insurance, licenses, bonds and financial arrangements.

If there are more than three (3) minority businesses within a 75 mile radius of the project who offer similar contracting or subcontracting services in the specific trade, the contractor(s) shall notify three (3), but may contact more, if the contractor(s) so desires.

- d. During the bidding process, comply with the contractor(s) requirements listed in these Guidelines and any contractor requirements listed in Union County's Minority and Small Business Participation Outreach Plan.
- e. Identify on the bid the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and submit affidavit listing Good Faith Efforts (Affidavit A) as required by G.S. §143-128.2(c) and G.S. §143-128.2(f). If the contractor will be performing all of the work with its own workforce, the contractor may submit Affidavit B, Intent to Perform Contract with Own Workforce," in lieu of Affidavit A. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
- f. Make documentation showing evidence of implementation of Prime Contractor, Construction Manager-at-Risk and First-Tier Subcontractor responsibilities available for review by the Owner and State officials upon request.

- g. Provide one of the following to Owner upon being named the apparent low bidder:
 - (1) an affidavit (Affidavit C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal; or
 - (2) if the percentage is not equal to the applicable goal, then an affidavit (Affidavit D) and documentation of all Good Faith Efforts taken to meet the goal. The documentation must include evidence of all good faith efforts that were implemented, including any advertisements, solicitation, and evidence of other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
- h. Within thirty (30) days after award of the contract, the apparent lowest responsible, responsive bidder shall file with Owner a list of all identified subcontractors that the contractor will use on the project.
- i. Identify the name(s) of minority business subcontractor(s) and corresponding dollar amount of work on the schedule of values. The schedule of values shall be provided as required in the General Conditions of the Contract to facilitate payments to the subcontractors.
- j. Submit with each monthly pay request and final payment request the “MBE Documentation for Contract Payment” - (Appendix E), for Designer’s review.
- k. If it any time during the construction of a project, if it becomes necessary to replace a minority business subcontractor, immediately advise the Owner in writing of the circumstances involved. The prime contractor shall make a good faith effort to replace a minority business subcontractor with another minority business subcontractor.
- l. Make a good faith effort to solicit subbids from minority businesses during the construction of a project if additional subcontracting opportunities become available.

In addition, a construction manager at risk shall submit its plan for compliance with N.C. Gen. Stat. § 143-128.2 for approval by the County prior to soliciting bids for the project’s first-tier subcontractors.

4. Minority Business Responsibilities

Union County does not certify minority businesses. Any business which desires to participate as a minority business under these Guidelines will be required to register and become certified as a historically underutilized business (“HUB”) by the North Carolina Department of Administration Office for Historically Underutilized Businesses (“HUB Office”). This system will replace all other HUB certification or registration programs currently (or formerly) used by public entities in North Carolina. Pursuant to G.S. 143-128.4(e), as of July 1, 2009, State agencies and local governments may count **only** those businesses that are certified as HUBs through the new statewide system to determine whether their participation goals have been met. In other words, a business that was registered as a HUB through a local government’s registration system but has not been certified as a HUB through the new statewide system will not count towards that local government’s participation goals.

Businesses seeking HUB certification need to go to:
<http://www.doa.state.nc.us/hub/prog-certification.htm>.

Minority HUB contractors shall make a good faith effort to participate in construction projects as demonstrated by:

- a. Attending the scheduled prebid conference.
- b. Responding promptly whether or not they wish to submit a bid when contacted by the Owner or bidders.
- c. Attending training and contractor outreach sessions given by the Owner, contractors and state agencies, when feasible.
- d. Participating in Mentor/Protégé programs, training, or other business development programs offered by the Owner, contractors or state agencies.
- e. Negotiating in good faith with the Owner or contractors.

SECTION D: DISPUTE PROCEDURES

It is the policy of this State that disputes that involve a person’s rights, duties or privileges should be settled through informal procedures. To that end, minority business disputes arising under these Guidelines should be resolved as governed under the dispute resolution process adopted by the State Building Commission pursuant to G.S. 143-135.26(11).

MINORITY BUSINESS CONSTRUCTION CONTRACT PROVISIONS

APPLICATION:

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in Union County Construction Contracts** are hereby made a part of these contract documents.

MINORITY BUSINESS SUBCONTRACT GOALS:

The goal for participation by minority firms as subcontractors on this project has been set at 10%.

The bidder must identify on its bid the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit (Affidavit A) listing good faith efforts or affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. §143-128.2(c) and G.S. 143-128.2(f).

In addition, the lowest responsible, responsive bidder must do one of the following:

(1) Provide Affidavit C that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal.

OR

(2) If the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, is less than the applicable goal, provide Affidavit D as well as documentation of Good Faith Efforts.

OR

(3) Provide Affidavit B, which includes sufficient information for the Owner to determine that the bidder does not customarily subcontract work on this type project.

The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.

MINIMUM COMPLIANCE REQUIREMENTS:

All written statements, affidavits or intentions made by the bidder shall become a part of the agreement between the Contractor and Union County for the performance of the contract. Failure to comply with any of these statements, affidavits or intentions, or with the minority business Guidelines shall constitute a breach of the contract. A finding by Union County that any information submitted either prior to award of the contract or during the performance of the contract is inaccurate, false or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of Union County whether to terminate the contract for breach.

In determining whether a contractor has made Good Faith Efforts, Union County will evaluate all efforts made by the Contractor and will determine compliance in regard to quantity, intensity, and results of these efforts. Bidders are required to earn at least 50 points from the good faith efforts listed below for their bid to be considered responsive. Failure to file a required affidavit or documentation demonstrating that the bidder made the required good faith efforts is grounds for rejection of the bid. Good Faith Efforts include:

- (1) Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the Contractor or available on State or local government maintained lists at least 10 days before the bid or proposal date and notifying them of the nature and scope of the work to be performed. Value = 10 points.
- (2) Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bid or proposals are due. Value = 10 points.
- (3) Breaking down or combining elements of work into economically feasible units to facilitate minority participation. Value = 15 points.
- (4) Working with minority trade, community, or contractor organizations identified by the Office for Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses. Value = 10 points.
- (5) Attending any prebid meetings scheduled by the public Owner. Value = 10 points.
- (6) Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors. Value = 20 points.
- (7) Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing. Value = 15 points.

- (8) Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit. Value = 25 points.
- (9) Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public building construction or repair project when possible. Value = 20 points.
- (10) Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands. Value = 20 points.

UNION COUNTY'S MINORITY AND SMALL BUSINESS PARTICIPATION OUTREACH PLAN

In addition to the good faith efforts set forth in the Guidelines for Recruitment and Selection of Minority Businesses for Participation in Union County Construction Contracts, Union County will also make the following good faith efforts in order to make it feasible for minority businesses to submit successful bids or proposals for contracts for building projects. Union County shall also make the following good faith efforts in the selection process for architectural, engineering, and construction manager at risk services.

1. Work with minority-focused and small business groups that support minority business and small business inclusion in the solicitation of bids. These groups include the Small Business Center Network (SBCN) (Anson & Union Counties), The Small Business and Technology Development Center (SBTDC), and The Union County Chamber of Commerce.
2. Place more emphasis on the importance of soliciting certified minority businesses and small businesses for subcontracting opportunities at pre-bid conferences and in the bid documents. Examine specifications to identify special subcontracting opportunities and strongly encourage prime contractors to solicit bids for subcontracts from minority businesses.
3. Provide detailed information to majority contractors concerning the Guidelines for Recruitment and Selection of Minority Business for Participation in Union County Construction Projects and this Outreach Plan (hereinafter referred to collectively as the "MBE Program") and provide information on G.S. 143-129 by holding meetings with the contractors.
4. Assess the effectiveness of the MBE Program, and identify opportunities to enhance it, by evaluating minority business participation and compliance and reviewing the "good faith efforts" provided in bid packages.
5. Identify subcontracting opportunities unique to each construction contract and project and concentrate heavily on targeting certified minority businesses and small businesses that have expressed an interest in Union County projects. Identify these opportunities and contact interested businesses no later than 10 days prior to the bid opening and provide a list of prime contractors plan to participate in the project.
6. Build new business relationships through networking and continue networking with other North Carolina cities and counties to find out how this MBE Program is working and sharing "best practices" and ideas to improve the program.

7. Participate in education opportunities throughout the community as they become available and offer training sessions to share the County's Outreach Plan with interested businesses and organizations.
8. Be visible through participation in trade shows and business organizations of interest to minority businesses, majority contractors and small businesses, and provide information to the general public about the MBE Program, and continue outreach efforts to the business community.
9. Enhance the County's web page by including the MBE Program, listing good faith efforts, and creating links to minority business resources, and creating awareness of specific subcontracting opportunities.
10. Make available to minority-focused agencies, a list of subcontracting opportunities when they are identified, no later than 10 days prior to the bid opening, and a list of prime bidders that subcontractors may wish to contact for subcontracting consideration.
11. Direct minority businesses to the Statewide historically underutilized business certification program in order to ensure those firms wishing to do business with Union County or any other public entity have access to up to date information.
12. Advertise upcoming bid opportunities in minority-focused media and on the county website at www.co.union.nc.us.
13. Work with architects and engineers to make subcontracting opportunities more noticeable and more easily understood by potential contractors and subcontractors.
14. Document telephone calls, emails and correspondence with or on behalf of minority businesses and encourage interested eligible firms to become NCDOT certified.

BID FORM

**UNION COUNTY PUBLIC WORKS DEPARTMENT
UNION COUNTY, NORTH CAROLINA
SP105 CROOKED CREEK WRF PROCESS IMPROVEMENTS
IFB # 2021-036**

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ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

**Union County Government Center
Attn: Vicky Watts
500 N. Main Street, Suite 709
Monroe, NC 28112**

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER’S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER’S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

<u>Addendum No.</u>	<u>Addendum, Date</u>
_____	_____
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and has satisfied itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and (2) reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.

- E. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and any 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; and (3) Bidder's safety precautions and programs.
- F. Bidder agrees, based on the information and observations referred to in the preceding paragraph, that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.
- G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
- H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and confirms that the written resolution thereof by Engineer is acceptable to Bidder.
- I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work.
- J. The submission of this Bid constitutes an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, and that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 4 – BIDDER'S CERTIFICATION

4.01 Bidder certifies that:

- A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 4.01.D:
 - 1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process;
 - 2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels; and
4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

ARTICLE 5 – BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

Lump Sum Bid Price	\$ _____
--------------------	----------

and

Lump Sum Pre-Negotiated Equipment Price	\$ _____
---	----------

and

Lump Sum Contingency Allowance	\$ 200,000
--------------------------------	------------

Total of All Lump Sums = Total Bid Price \$ _____

ARTICLE 6 – TIME OF COMPLETION

- 6.01 Bidder agrees that the Work will be substantially complete within **330** calendar days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within **360** calendar days after the date when the Contract Times commence to run.
- 6.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 7 – ATTACHMENTS TO THIS BID

- 7.01 The following documents are submitted with and made a condition of this Bid:
 - A. Required Bid security;
 - B. List of Proposed Subcontractors;
 - C. List of Proposed Suppliers;
 - D. List of Project References;
 - E. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such license within the time for acceptance of Bids;
 - F. Contractor's License No.: _____;
 - G. Required Bidder Qualification Statement with supporting data

CERTIFIED LIST OF PROPOSED MANUFACTURERS/ SUBCONTRACTORS

As part of the procedure for submission of Bids on this project, Bidder submits the following lists of Subcontractors and Suppliers to be used in the performance of work to be done on said Project. The lists furnished 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 upon review of Contractor's submittals.

CATEGORY	SUBCONTRACTOR
Electrical	
HVAC / Mechanical	
Plumbing	

SCHEDULE OF SUPPLIERS

The following **Major Equipment & Supplier Table** designates items which shall be identified by the Bidder upon submittal of Bid.

1. The Bidder must circle one (1) named supplier for each item listed in the table. The named supplier circled for each equipment item will identify whose equipment is included in the Bidder's Lump Sum Bid Price and whose equipment will be supplied by the Bidder during construction. If no supplier is circled for any equipment item, the Owner will choose the named manufacturer whose equipment will be supplied by the Bidder at no adjustment of the Bidder's Lump Sum Bid Price.
2. Owner acceptance of equipment supplied by a named manufacturer or supplier does not constitute a waiver of the Specifications.
3. Equipment by a manufacturer or supplier not named in the referenced equipment specification will be considered for equivalence to the Acceptable Manufacturer(s) listed in the referenced equipment specification **during the bid period only** in accordance with Article 11 of the Instructions to Bidders. A non-named manufacturer shall demonstrate full compliance with the specifications in all aspects including form, features, construction materials, O&M cost, mechanical and control functionality, performance reliability, quality, and general configuration. To be considered, non-named manufacturers shall submit the following information to the Engineer and Owner within the time allowed in accordance with Article 11 of the Instructions to Bidders:
 - a. Dimensional and weight information on components and assemblies.
 - b. A list of any requested exceptions to the Contract Documents.
 - c. Catalog information and cuts.
 - d. Manufacturer's specifications, including materials description.
 - e. Performance data as applicable.
 - f. Field interface requirements for each component, such as, but not limited to water and drain connections, electricity (field wiring requirements), air supply connections, ventilation, etc.
 - g. Horsepower of all motors supplied.
 - h. Functional descriptions of any packaged instrumentation and control systems.
 - i. List of parameters monitored, controlled, or alarmed.
 - j. Addresses and phone numbers of nearest service center and a listing of the manufacturer's or supplier's services available at this location.
 - k. Addresses and phone numbers for the nearest parts warehouse capable of providing full parts replacement and/or repair service.
 - l. A list of the manufacturer's five (5) most recent domestic (USA) installations with similar size equipment in service. Include contact name, telephone number, mailing address, and names of Engineer, Owner, and installing Contractor.
 - m. Description of structural, electrical, mechanical, and all other changes or modifications necessary to adapt the equipment or system to the arrangement shown and/or functions described in the Specifications and/or Drawings.
 - n. Any additional specific requirements listed in the referenced equipment specification.
4. Failure to include all listed information with the submittal shall result in a determination that the non-named equipment manufacturer is not considered "or equal" and, therefore, not acceptable.

5. The Engineer and Owner will determine if the non-named manufacturer's equipment will be added as a named manufacturer ("or equal") in the referenced equipment specification. Final determination is at the sole discretion of the Engineer and Owner, and will occur prior to the Bid opening. There will be no process to appeal this determination.
6. If the Engineer and Owner determine that any non-named manufacturer is considered equivalent ("or-equal") to the named manufacturer(s), the referenced equipment specification will be revised by Addendum to include additional named manufacturers. However, addition of a manufacturer by addendum shall not relieve the Bidder of full responsibility for any facility redesign or other costs required to install the equipment. The manufacturer/ supplier and Bidder shall comply with the following during construction:
 - a. Manufacturer/Supplier shall include in his quote to potential Bidders all additional construction costs (mechanical, architectural, structural, electrical, and engineering redesign costs) associated with the proposed equipment. The Bid shall also include all paid licenses necessary for the use of the proposed equipment, if required by the manufacturer.
 - b. Any redesign associated with the proposed equipment shall be prepared by the Engineer. Reimbursement for engineering redesign shall be based on the Engineer's raw salary costs times a multiplier of 3.15 plus any direct, non-labor expenses such as travel, per diem, or reproduction services. The Owner will bill the Contractor monthly based on the Engineer's invoice to the Owner. The Contractor shall reimburse the Owner, who will in turn reimburse the Engineer, within 30 days of receipt of the Owner's billing. Non-payment within 30 days shall constitute grounds for the Owner to withhold partial payment to Contractor.
 - c. Bidder agrees that delays caused by redesign necessary for the proposed equipment shall not constitute grounds for a contract modification, change order, claim, or contract time extension.
7. The Major Equipment Table is provided with blank spaces for an "or equal" equipment item approved by the Engineer and named via addendum during the Bid period, in accordance with Article 11 of the Instructions to Bidders.

Major Equipment Table

(Circle Only One Supplier / Manufacturer Named in the Reference Specification Section)

Specification Section	Equipment	Manufacturer to be Provided
43 25 15	Submersible Chopper Pumps	<ul style="list-style-type: none">• Vaughan• Hayward Gordon• _____
46 51 19	Rotary Disc Surface Aerators	<ul style="list-style-type: none">• Evoqua• _____
40 05 57	480 V Electric Valve Actuators	<ul style="list-style-type: none">• Rotork• Limitorque• _____
40 61 13	Instrumentation and Control System Subcontractor	<ul style="list-style-type: none">• CITI• R S Integrators• _____

ARTICLE 8 – DEFINED TERMS

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

ARTICLE 9 – BID SUBMITTAL

BIDDER: *[Indicate correct name of bidding entity]*

By: _____
[Signature]

[Printed name]
(If Bidder is a corporation, a limited liability company, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
[Signature]

[Printed name]

Title: _____

Submittal Date: _____

Address for giving notices:

Telephone Number: _____

Fax Number: _____

Contact Name and e-mail address: _____

Bidder's License No.: _____
(where applicable)

NOTE TO USER: Use in those states or other jurisdictions where applicable or required.

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BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:

SURETY *(Name and Address of Principal Place of Business)*:

OWNER *(Name and Address)*:

BID

Bid Due Date:

Description *(Project Name and Include Location)*:

BOND

Bond Number:

Date *(Not earlier than Bid due date)*:

Penal sum _____ \$ _____
(Words) (Figures)

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

BIDDER

SURETY

Bidder's Name and Corporate Seal (Seal)

Surety's Name and Corporate Seal (Seal)

By: _____
Signature

By: _____
Signature (Attach Power of Attorney)

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

Note: Above addresses are to be used for giving any required notice. Provide execution by any additional parties, such as joint venturers, if necessary.

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

Notice of Award

Date: _____

Project: SP105 Crooked Creek WRF Process Improvements

Owner: **UNION COUNTY**

Owner's Contract No.:

Contract:

Engineer's Project No.:

Bidder:

Bidder's Address: *[send Notice of Award Certified Mail, Return Receipt Requested]*

You are notified that your Bid dated ___ for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for

[Indicate total Work, alternates, or sections of Work awarded.]

The Contract Price of your Contract is _____ Dollars (\$_____).

[Insert appropriate data if unit prices are used. Change language for cost-plus contracts.]

___ copies of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

___ sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within ten (10) days of the date you receive this Notice of Award.

1. Deliver to the Owner five (5) fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20) and General Conditions (Paragraph 5.01)

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

Within thirty (30) days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

Owner
By: _____
Authorized Signature

Title

Copy to Engineer

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**SUGGESTED FORM OF AGREEMENT
BETWEEN OWNER AND CONTRACTOR
FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)**

THIS AGREEMENT is by and between _____ UNION COUNTY _____ (“Owner”) and

_____ (“Contractor”).

Owner and Contractor hereby agree as follows:

ARTICLE 1 – WORK

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

UNION COUNTY PUBLIC WORKS DEPARTMENT
UNION COUNTY, NORTH CAROLINA
SP105 CROOKED CREEK WRF PROCESS IMPROVEMENTS
IFB # 2021-036

ARTICLE 2 – THE 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:

The project consists of a Single Prime Contract for furnishing all materials and labor for upgrades to the Crooked Creek WRF.

ARTICLE 3 – ENGINEER

- 3.01 The Project has been designed by **Hazen and Sawyer**, (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 the 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.

- 4.02 *Days to Achieve Substantial Completion and Final Payment*

A. The Work will be substantially completed within **330** days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed

and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within **360** days after the date when the Contract Times commence to run.

4.03 *Liquidated Damages*

- A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal ~~or arbitration~~ proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner \$500.00 for each day that expires after the time specified in Paragraph 4.02 above for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner \$500.00 for each day that expires after the time specified in Paragraph 4.02 above for completion and readiness for final payment until the Work is completed and ready for final payment.
- B. **In addition to liquidated damages, Contractor shall reimburse Owner all fees and costs paid to or incurred by Engineer in administering the construction of the Project beyond the time specified in Paragraph 4.02 above for Substantial Completion. All fees and costs may be deducted from monies due Contractor for the performance of the Work.**

ARTICLE 5 – CONTRACT PRICE

5.02 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A, 5.01.B, and 5.01.C below:

A. For all Work other than Unit Price Work, a lump sum of: \$ _____

All specific cash allowances are included in the above price in accordance with Paragraph 11.02 of the General Conditions.

B. (Not used)

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

ARTICLE 6 – PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

- A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions. **Owner shall make payments within thirty (30) days after presentation of the**

Application for Payment to Owner by Engineer with Engineer's recommendation for payment.

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 **on or about the ____ day of each month** during performance of the Work as provided in Paragraph 6.02.A.1 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements.
1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions.
 - a. **95%** percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and
 - b. **95%** percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
- B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to **100%** percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less **200%** percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

6.03 *Final Payment*

- A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07.

ARTICLE 7 – INTEREST

- 7.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of **4%** percent per annum.

ARTICLE 8 – CONTRACTOR’S REPRESENTATIONS

- 8.01 In order to induce 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 all federal, state, and local 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 Paragraph SC-4.02 of the Supplementary Conditions as containing reliable "technical data," and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in Paragraph SC-4.06 of the Supplementary Conditions 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 any 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 **an** understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 9 – CONTRACT DOCUMENTS

9.01 Contents

A. The Contract Documents consist of the following:

1. This Agreement (pages ____ to ____, inclusive).
2. Performance bond (pages ____ to ____, inclusive).
3. Payment bond (pages ____ to ____, inclusive).
4. Other bonds (pages ____ to ____, inclusive).
 - a. ____ (pages ____ to ____, inclusive).
 - b. ____ (pages ____ to ____, inclusive).
 - c. ____ (pages ____ to ____, inclusive).
5. General Conditions (pages ____ to ____, inclusive).
6. Supplementary Conditions (pages ____ to ____, inclusive).
7. Specifications as listed in the table of contents of the Project Manual.
8. Drawings consisting of ____ sheets with each sheet bearing the following general title: SP104 Olde Sycamore WRF Process Improvements. **Drawings are separately bound and therefore not attached to this Agreement.**
9. Addenda (numbers ____ to ____, inclusive).
10. Exhibits to this Agreement (enumerated as follows):
 - a. Contractor’s Bid (pages ____ to ____, inclusive).
 - b. Documentation submitted by Contractor prior to Notice of Award (pages ____ to ____, inclusive).
11. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
 - a. Notice to Proceed (pages ____ to ____, inclusive).
 - b. Work Change Directives.
 - c. Change Orders.

B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).

- C. There are no Contract Documents other than those listed above in this Article 9.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 10 – MISCELLANEOUS

10.01 Terms

- A. Terms used in this Agreement will have the meanings stated 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 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 10.05:
 1. "corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process or in the Contract execution;
 2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to

- establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;
3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and
 4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement. Counterparts have been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or have been identified by Owner and Contractor or on their behalf.

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

OWNER:

CONTRACTOR

UNION COUNTY _____

By: _____

By: _____

Title: County Manager _____

Title: _____

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

Attest: _____

Attest: _____

Title: _____

Title: _____

Address for giving notices:

Address for giving notices:

500 N. Main Street _____

Suite 600 _____

Monroe, NC 28112 _____

License No.: _____

(Where applicable)

Agent for service of process:

Notice to Proceed

Date: _____

Project: SP105 Crooked Creek WRF Process Improvements	
Owner: UNION COUNTY	Owner's Contract No.:
Contract:	Engineer's Project No.:
Contractor:	
Contractor's Address: [send Certified Mail, Return Receipt Requested]	

You are notified that the Contract Times under the above Contract will commence to run on _____. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the date of Substantial Completion is _____, and the date of readiness for final payment is _____ [(or) the number of days to achieve Substantial Completion is _____, and the number of days to achieve readiness for final payment is _____].

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds and loss payees) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must:

[add other requirements].

_____	UNION COUNTY
_____	Owner
_____	Given by:
_____	Authorized Signature
_____	Title
_____	Date

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PERFORMANCE BOND

CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*: **UNION COUNTY**
500 N. Main Street, Suite 600
Monroe, North Carolina, 28112

CONSTRUCTION CONTRACT

Effective Date of the Agreement:

Amount:

Description *(name and location)*: SP105 Crooked Creek WRF Process Improvements

BOND

Bond Number:

Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:

Amount:

Modifications to this Bond Form: None See Paragraph 16

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

CONTRACTOR AS PRINCIPAL

SURETY

Contractor's Name and Corporate Seal *(seal)*

Surety's Name and Corporate Seal *(seal)*

By: _____
Signature

By: _____
Signature *(attach power of attorney)*

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

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

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

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after:

3.1 The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;

3.2 The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

3.3 The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of

the Contract Price incurred by the Owner as a result of the Contractor Default; or

5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

7.1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

7.2 additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

7.3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within

two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

14. Definitions

14.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

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

14.3 Contractor Default: Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

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

14.5 Contract Documents: All the documents that comprise the agreement between the Owner and Contractor.

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

16. Modifications to this Bond are as follows:

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PAYMENT BOND

CONTRACTOR *(name and address)*:

SURETY *(name and address of principal place of business)*:

OWNER *(name and address)*: **UNION COUNTY**
 500 N. Main Street, Suite 600
 Monroe, North Carolina 28112

CONSTRUCTION CONTRACT

Effective Date of the Agreement:

Amount:

Description *(name and location)*: SP105 Crooked Creek WRF Process Improvements

BOND

Bond Number:

Date *(not earlier than the Effective Date of the Agreement of the Construction Contract)*:

Amount:

Modifications to this Bond Form: None See Paragraph 18

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

CONTRACTOR AS PRINCIPAL

SURETY

(seal)
 Contractor's Name and Corporate Seal

(seal)
 Surety's Name and Corporate Seal

By: _____
 Signature

By: _____
 Signature *(attach power of attorney)*

 Print Name

 Print Name

 Title

 Title

Attest: _____
 Signature

Attest: _____
 Signature

 Title

 Title

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

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

(2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

16.1 **Claim:** A written statement by the Claimant including at a minimum:

1. The name of the Claimant;
2. The name of the person for whom the labor was done, or materials or equipment furnished;
3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
4. A brief description of the labor, materials, or equipment furnished;
5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
7. The total amount of previous payments received by the Claimant; and
8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2 **Claimant:** An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond

shall be to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

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

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

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

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

18. Modifications to this Bond are as follows:

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Contractor's Application for Payment No. _____

Application Period:		Application Date:
To UNION COUNTY (Owner): 500 N. Main Street, Suite 600, Monroe, NC 28112	From (Contractor):	Via (Engineer):
Project: SP105 Crooked Creek WRF Process Improvements	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

**Application For Payment
Change Order Summary**

Approved Change Orders			1. ORIGINAL CONTRACT PRICE.....	\$ _____
Number	Additions	Deductions	2. Net change by Change Orders.....	\$ _____
			3. Current Contract Price (Line 1 ± 2).....	\$ _____
			4. TOTAL COMPLETED AND STORED TO DATE (Column F on Progress Estimate).....	\$ _____
			5. RETAINAGE:	
			a. X _____ Work Completed.....	\$ _____
			b. X _____ Stored Material.....	\$ _____
			c. Total Retainage (Line 5a + Line 5b).....	\$ _____
			6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c).....	\$ _____
			7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application).....	\$ _____
			8. AMOUNT DUE THIS APPLICATION.....	\$ _____
			9. BALANCE TO FINISH, PLUS RETAINAGE (Column G on Progress Estimate + Line 5 above).....	\$ _____
TOTALS				
NET CHANGE BY CHANGE ORDERS				

Contractor's Certification

The undersigned Contractor certifies that to the best of its knowledge: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

By: _____ Date: _____

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ (Date) _____ (Date)
(Engineer)

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ (Date) _____ (Date)
(Owner) - UNION COUNTY

Approved by: _____ (Date) _____ (Date)
Funding Agency (if applicable)

**Engineers Joint Documents Committee
Design and Construction Related Documents
Instructions and License Agreement**

Instructions

Before you use any EJCDC document:

1. Read the License Agreement. You agree to it and are bound by its terms when you use the EJCDC document.
2. Make sure that you have the correct version for your software.

How to Use:

1. While EJCDC has expended considerable effort to make the software translations exact, it can be that a few document controls (e.g., bold, underline) did not carry over.
2. Similarly, your software may change the font specification if the font is not available in your system. It will choose a font that is close in appearance. In this event, the pagination may not match the control set.
3. If you modify the document, you must follow the instructions in the License Agreement about notification.
4. Also note the instruction in the License Agreement about the EJCDC copyright.

License Agreement

You should carefully read the following terms and conditions before using this document.

Commencement of use of this document indicates your acceptance of these terms and conditions. If you do not agree to them, you should promptly return the materials to the vendor, and your money will be refunded.

The Engineers Joint Contract Documents Committee ("EJCDC") provides **EJCDC Design and Construction Related Documents** and licenses their use worldwide. You assume sole responsibility for the selection of specific documents or portions thereof to achieve your intended results, and for the installation, use, and results obtained from **EJCDC Design and Construction Related Documents**.

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2. Use **EJCDC Design and Construction Related Documents** in printed form for bona fide contract documents.
3. Copy **EJCDC Design and Construction Related Documents** into any machine readable or printed form for backup or modification purposes in support of your use of **EJCDC Design and Construction Related Documents**.

You agree that you will:

1. Reproduce and include EJCDC's copyright notice on any printed or machine-readable copy, modification, or portion merged into another document or program. All proprietary rights in **EJCDC Design and Construction Related Documents** are and shall remain the property of EJCDC.
2. Not represent that any of the contract documents you generate from **EJCDC Design and Construction Related Documents** are EJCDC documents unless (i) the document text is used without alteration or (ii) all additions and changes to, and deletions from, the text are clearly shown.

You may not use, copy, modify, or transfer EJCDC Design and Construction Related Documents, or any copy, modification or merged portion, in whole or in part, except as expressly provided for in this license. Reproduction of EJCDC Design and Construction Related Documents in printed or machine-readable format for resale or educational purposes is expressly prohibited.

If you transfer possession of any copy, modification or merged portion of EJCDC Design and Construction Related Documents to another party, your license is automatically terminated.

Term:

The license is effective until terminated. You may terminate it at any time by destroying **EJCDC Design and Construction Related Documents** altogether with all copies, modifications and merged portions in any form. It will also terminate upon conditions set forth elsewhere in this Agreement or if you fail to comply with any term or condition of this Agreement. You agree upon such termination to destroy **EJCDC Design and Construction Related Documents** along with all copies, modifications and merged portions in any form.

Limited Warranty:

EJCDC warrants the CDs and diskettes on which **EJCDC Design and Construction Related Documents** is furnished to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of delivery to you as evidenced by a copy of your receipt.

There is no other warranty of any kind, either expressed or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

EJCDC does not warrant that the functions contained in **EJCDC Design and Construction Related Documents** will meet your requirements or that the operation of **EJCDC Design and Construction Related Documents** will be uninterrupted or error free.

Limitations of Remedies:

EJCDC's entire liability and your exclusive remedy shall be:

1. the replacement of any document not meeting EJCDC's "Limited Warranty" which is returned to EJCDC's selling agent with a copy of your receipt, or
2. if EJCDC's selling agent is unable to deliver a replacement CD or diskette which is free of

defects in materials and workmanship, you may terminate this Agreement by returning EJCDC Document and your money will be refunded.

In no event will EJCDC be liable to you for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use or inability to use **EJCDC Design and Construction Related Documents** even if EJCDC has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

General:

You may not sublicense, assign, or transfer this license except as expressly provided in this Agreement. Any attempt otherwise to sublicense, assign, or transfer any of the rights, duties, or obligations hereunder is void.

This Agreement shall be governed by the laws of the State of Virginia. Should you have any questions concerning this Agreement, you may contact EJCDC by writing to:

Arthur Schwartz, Esq.
General Counsel
National Society of Professional
Engineers
1420 King Street
Alexandria, VA 22314

Phone: (703) 684-2845
Fax: (703) 836-4875
e-mail: aschwartz@nspe.org

You acknowledge that you have read this agreement, understand it and agree to be bound by its terms and conditions. You further agree that it is the complete and exclusive statement of the agreement between us which supersedes any proposal or prior agreement, oral or written, and any other communications between us relating to the subject matter of this agreement.

Certificate of Substantial Completion

Project: SP105 Crooked Creek WRF Process Improvements

Owner: **UNION COUNTY**

Owner's Contract No.:

Contract:

Engineer's Project No.:

This [tentative] [definitive] Certificate of Substantial Completion applies to:

- All Work under the Contract Documents: 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 Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

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

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:

- Amended Responsibilities Not Amended

Owner's Amended Responsibilities:

Contractor's Amended Responsibilities:

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.

This document has been modified by Owner. Changes are shown in bold text with additions underlined and deletions struck through. The Table of Contents has been updated to reflect modifications.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

ACEC

AMERICAN COUNCIL OF ENGINEERING COMPANIES



ASCE American Society
of Civil Engineers

P/E National Society of
Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

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Endorsed by



CONSTRUCTION SPECIFICATIONS INSTITUTE

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor (EJCDC C-520 or C-525, 2007 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the Narrative Guide to the EJCDC Construction Documents (EJCDC C-001, 2007 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (EJCDC C-800, 2007 Edition).

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www.agc.org

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.
 3. *Application for Payment*—The form acceptable to Engineer **and Owner** which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Asbestos*—Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.
 5. *Bid*—The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 6. *Bidder*—The individual or entity who submits a Bid directly to Owner.
 7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).
 8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders **(including any bid schedule)**, Bid security of acceptable form, if any, and the Bid Form with any supplements.
 9. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.
 10. *Claim*—A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.
 11. *Contract*—The entire and integrated written ~~agreement~~ **Agreement** between the Owner and Contractor concerning the Work. The Contract supersedes prior **and contemporaneous** negotiations, representations, or agreements, whether written or oral. **The Contract may**

not be modified or altered except by a writing signed by both the Owner and Contractor.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.
13. *Contract Price*—The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).
14. *Contract Times*—The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any; (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.
15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.
16. *Cost of the Work*—See Paragraph 11.01 for definition.
17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.
18. *Effective Date of the Agreement*—The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
19. *Engineer*—The individual or entity named as such in the Agreement.
20. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.
21. *General Requirements*—~~Sections of~~ Division 1 of the Specifications.
22. *Hazardous Environmental Condition*—The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto.
23. *Hazardous Waste*—The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.
24. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*—A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.
27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.
28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.
29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.
30. *PCBs*—Polychlorinated biphenyls.
31. *Petroleum*—Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.
32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.
34. *Project Manual*—The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.
35. *Radioactive Material*—Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.
36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.
37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals **and Shop Drawings** and the time requirements to support scheduled performance of related construction activities.
39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

40. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.
41. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.
42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.
43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.
44. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized **or occupied** for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or **a specified** part of the Work refer to Substantial Completion thereof.
45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.
46. *Supplementary Conditions*—That part of the Contract Documents which amends or supplements these General Conditions.
47. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or Subcontractor.
48. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
49. *Unit Price Work*—Work to be paid for on the basis of unit prices.
50. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.
51. *Work Change Directive*—A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and recommended by Engineer ordering an

addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day:*

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

D. *Defective:*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide:*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

- A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor up to ~~ten~~ **five** printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

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

2.04 *Starting the Work*

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

2.05 *Before Starting Construction*

- A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:
 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;
 2. a preliminary Schedule of Submittals; and
 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.
- B. At this conference Owner, **Engineer**, and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 *Initial Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the ~~schedules~~ **Progress Schedule** submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the ~~schedules.~~ **Progress Schedule.** No progress payment shall be made to Contractor until **an** acceptable ~~schedules are~~ **Project Schedule is** submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

- A. The Contract Documents are **complementary; fully-integrated;** what is required by **one each document which is part of the Contract Documents** is as binding as if required **by or set forth in all of the Contract Documents.**
- B. It is the intent of the Contract Documents to describe a functionally complete **project Project** (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.
- C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

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

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.
2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*

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

3.04 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.
- B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:
 1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or
3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

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

3.06 *Electronic Data*

- A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.
- B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.
- C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

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

comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

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

4.02 *Subsurface and Physical Conditions*

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

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and
2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

C. **Site Visit: Contractor represents that is has visited the Site and has become familiar with and satisfied as to the general, local, and Site conditions that may affect cost, progress, performance, and furnishing of the Work.**

4.03 *Differing Subsurface or Physical Conditions*

- A. *Notice:* If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:
1. is of such a nature as to establish that any “technical data” on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
 2. is of such a nature as to require a change in the Contract Documents; or
 3. differs materially from that shown or indicated in the Contract Documents; or
 4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, **promptly within twenty-four (24) hours** after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

- B. *Engineer’s Review:* After receipt of written notice as required by Paragraph 4.03.A, Engineer **will promptly shall within seven (7) calendar days** review the pertinent condition, determine the necessity of Owner’s obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer’s findings and conclusions.

C. *Possible Price and Times Adjustments:*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and
 - b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs ~~9.07~~ **9.06** and 11.03-; **and**
 - c. **Contractor shall not be entitled to, and Owner shall not be liable for, any remobilization fees or equipment charges as a result of any work stoppage pursuant to Paragraph 4.03.**
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:
 - a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

- b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or
 - c. Contractor failed to give the written notice as required by Paragraph 4.03.A.
 3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information, ~~and~~ **data, and locations** shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and
2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all such information and data;
 - b. locating all Underground Facilities shown or indicated in the Contract Documents;
 - c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction; and
 - d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated:*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, **promptly within twenty-four (24) hours** after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer ~~will promptly~~ **shall within forty-eight (48) hours** review

the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such ~~consequences.~~ **change.** An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

- A. *Reports and Drawings:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.
- B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
 1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
 2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.
- D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall **promptly within seven (7) calendar days** 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~~ **After** consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.
- E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered written notice to Contractor: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.
- F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner’s own forces or others in accordance with Article 7.
- ~~G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by~~

~~Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.~~

- H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

The Contractor shall provide surety bonds wherein surety waives notice of any and all modifications, omissions, additions, changes and advance payments or deferred payments in or about the Contract, and agrees that the obligations undertaken by the bond shall not be impaired in any manner by reason of such modifications, omissions, additions, changes, and advance payments or deferred payments. The surety bond must set forth no requirement that suit be initiated prior to the time stipulated in applicable North Carolina statutes of limitation.

- B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.
- C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner

and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

- A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required **and have a financial standing rating from A.M. Best Company equal to or better than A-VII.** Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

- A. Contractor shall deliver to Owner, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.
- B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.
- C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.
- D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.
- E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Insurance*

- A. Contractor shall purchase and maintain such insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:
 - 1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;
 3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;
 4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:
 - a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or
 - b. by any other person for any other reason;
 5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and
 6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.
- B. The policies of insurance required by this Paragraph 5.04 shall:
1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;
 2. include at least the specific coverages and be written for not less than the limits of liability provided in ~~the Supplementary Conditions~~ **Paragraph 5.04(C)** or required by Laws or Regulations, whichever is greater;
 3. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;
 4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);
 5. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and

- 6. include completed operations coverage:
 - a. Such insurance shall remain in effect for two years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

C. The Policies of insurance required by Paragraph 5.04 shall include the specific coverages and be written for not less than the limits of liability provided below or required by Laws or Regulations, whichever is greater.

Worker's Compensation and Employer's Liability Insurance. This insurance shall protect Contractor against all claims under applicable state workers' compensation laws, including coverage as necessary for the benefits provided under the United States Longshoremen's and Harbor Workers' Act and the Jones Act. Contractor shall also be protected against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. This policy shall include an "all states" or "other states" endorsement.

The liability limits shall be not less than:

<u>Workers' compensation</u>	<u>Statutory</u>
<u>Employers' liability</u>	<u>\$1,000,000 each occurrence</u>

Business Automobile Liability Insurance. This insurance shall be occurrence type, written on Insurance Services Office (ISO) form CA 00 01, or a substitute form providing equivalent liability coverage, and shall protect Contractor, Owner, and Engineer as additional insureds, against all claims for injuries to members of the public and damage to property of others arising from the use of motor vehicles, either on or off the project site whether they are owned, nonowned, or hired.

The liability limits shall be not less than:

<u>Bodily injury and property damage</u>	<u>\$1,000,000 combined single limit for each occurrence</u>
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Commercial General Liability Insurance. This insurance shall be written on ISO “occurrence” form CG 00 01 or its equivalent, and shall protect Contractor, Owner, and Engineer as additional insureds, against claims arising from injuries, sickness, disease, or death of any person or damage to property arising out of performance of the Work. The Owner shall be included as an additional insured by ISO endorsements CG 20 10 or CG 20 33 and CG 20 37 or their equivalents; and the Engineer as additional insured by ISO endorsement CG 20 07 or CG 20 32 or its equivalent. The policy shall also include a per project aggregate limit endorsement, personal injury liability coverage, contractual liability coverage, completed operations and products liability coverage, and coverage for blasting, explosion, collapse of buildings, and damage to underground property.

The liability limits shall be not less than:

<u>Bodily injury and property damage</u>	<u>\$1,000,000 combined single limit for each occurrence</u>
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\$1,000,000 general aggregate

Umbrella Liability Insurance. This insurance shall protect Contractor, Owner, and Engineer as additional insureds, against claims in excess of the limits provided under workers' compensation and employers' liability, business automobile liability, and commercial general liability policies. The umbrella policy shall follow the form of the primary insurance, including the application of the primary limits.

The liability limits shall be not less than:

<u>Bodily injury and property damage</u>	<u>\$4,000,000 combined single limit for each occurrence</u>
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\$4,000,000 general aggregate

5.05 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

- A. Unless otherwise provided in the Supplementary Conditions, ~~Owner~~ **Contractor** shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;
2. be written on a Builder's Risk "all-risk" policy form that shall at **a minimum cover the perils under the ISO special causes of loss policy form (CP 10 30) and least** include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions.

CONTRACTOR shall purchase and maintain boiler and machinery insurance required by the contract documents or by law, covering insured objects during installation and until final acceptance by Owner. In lieu of this separate policy, the contractor may have the boiler and machinery exclusion removed from the builder's risk policy.

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;
 5. allow for partial utilization of the Work by Owner;
 6. include testing and startup; and
 7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued.
- B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.
- C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

- ~~D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.~~
- E. If ~~Contractor~~ Owner requests in writing that other special insurance be included in the property insurance policies provided under this Paragraph 5.06, ~~Owner~~ Contractor shall, if possible, include such insurance, and the cost thereof will be charged to ~~Contractor~~ Owner by appropriate Change Order. Prior to commencement of the Work at the Site, ~~Owner~~ Contractor shall in writing advise ~~Contractor~~ Owner whether or not such other insurance has been procured by ~~Owner~~. Contractor.

5.07 *Waiver of Rights*

- A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.
- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:
1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

- A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner ~~as fiduciary~~ for the loss payees, as their interests may appear, subject to the requirements of ~~any applicable mortgage clause and of~~ Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.
- B. Owner ~~as fiduciary~~ shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner ~~as fiduciary~~ shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Owner ~~as fiduciary~~ shall adjust and settle the loss with the insurers ~~and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.~~

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

- A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

- A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by

endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR’S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. ~~Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.~~
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer **except under extraordinary circumstances.**

6.02 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
- B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner’s written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

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

6.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.
1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.
 2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.
1. "*Or-Equal*" Items: If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and
 - 3) it has a proven record of performance and availability of responsive service.
 - b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. *Substitute Items:*

- a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.
- b. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.
- c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.
- d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - 1) shall certify that the proposed substitute item will:
 - a) perform adequately the functions and achieve the results called for by the general design,
 - b) be similar in substance to that specified, and
 - c) be suited to the same use as that specified;
 - 2) will state:
 - a) the extent, if any, to which the use of the proposed substitute item will **prejudice** **delay** Contractor's achievement of Substantial Completion on time,
 - b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
 - c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;
 - 3) will identify:
 - a) all variations of the proposed substitute item from that specified, and
 - b) available engineering, sales, maintenance, repair, and replacement services; and
 - 4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

- B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.
- C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.
- D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- E. *Engineer's Cost Reimbursement:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
- F. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.
- B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or

entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

- C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:
1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor
 2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.
- D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.
- E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.
- F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its

use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

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

6.08 *Permits*

- A. Unless otherwise provided in the Supplementary Conditions, ~~Contractor~~ Owner shall obtain and pay for all construction permits and licenses. ~~Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement.~~ Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

- C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.
- B. **Pursuant to N.C.G.S. § 105-164.14, Owner is eligible for sales and use tax refunds on all materials which become a permanent part of the construction. Contractor agrees to provide Owner such documentation as may be necessary to meet the requirements of the North Carolina Department of Revenue regarding requests for refund of sales and use taxes. Such requirements include those described in the North Carolina Department of Revenue Sales and Use Tax Technical Bulletins § 18-2(F), outlined below:**
1. **To substantiate a refund claim for sales or use taxes paid on purchases of building materials, supplies, fixtures, and equipment by a contractor, Owner must secure from a contractor certified statements setting forth the specific required information. A “certified statement” is a statement signed by a contractor’s owner, a corporate officer of a contractor, or an employee of a contractor who is authorized to provide information set forth in the statement. The certified statement must include all of the following information:**
 - a. **The date the property was purchased;**
 - b. **The type of property purchased;**
 - c. **The cost of property purchased and the amount of sales and use taxed paid thereon;**
 - d. **The vendor from whom the property was purchased;**
 - e. **The project for which the property was purchased;**
 - f. **If the property was purchased in the State of North Carolina, the county to which it was delivered, or, if the property was not purchased in the State of North Carolina, the county in which the property was used; and**
 - g. **The invoice number of the purchase.**
 2. **In the event Contractor makes several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, and the State and local sales and use taxes paid thereon. Such statement must also include the cost of any tangible personal property withdrawn from Contractor’s warehouse stock and the amount of State and local sales or use tax paid thereon by Contractor. Any local sales or use taxes included in Contractor’s**

statements must be shown separately from the State sales or use taxes. Contractor's statements must not contain sales or use taxes paid on purchases of tangible personal property purchased by Contractor for use in performing the Contract which does not annex to, affix to or in some manner become a part of the building or structure that is owned or leased by a governmental agency and is being erected, altered or repaired for use by a governmental entity as defined by N.C.G.S. § 105-164.14(c). Examples of property on which sales or use tax has been paid by Contractor and which shall not be included in Contractor's certified statement are scaffolding, forms for concrete, fuel for the operation of machinery and equipment, tools, equipment, equipment repair parts and equipment rentals. Similar certified statements by Subcontractors must be obtained by Contractor and furnished to Owner.

3. **Contractor shall submit notarized sales tax certificates which meet the requirements detailed above with each Application for Payment. Payment will not be made until the sales tax certificate(s) have been submitted to Owner. Owner is the recipient of sales tax refunds and no such funds shall be provided to Contractor, or claim made by Contractor therefor.**

6.11 *Use of Site and Other Areas*

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

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.
2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by ~~arbitration or other~~ dispute resolution proceeding or at law.
3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

- B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

- C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.
- D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

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

6.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.
- C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

- D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
- E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor ~~(except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).~~
- F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

- A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

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

6.16 *Emergencies*

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

6.17 *Shop Drawings and Samples*

- A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*
 - a. Submit number of copies specified in the General Requirements.
 - b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.
 2. *Samples:*
 - a. Submit number of Samples specified in the Specifications.
 - b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.
- B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Submittal Procedures:*
1. Before submitting each Shop Drawing or Sample, Contractor shall have:
 - a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
 2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.
 3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and ~~submit~~, **resubmit**, 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. **All resubmittals by Contractor to Engineer shall be within fourteen (14) calendar days after receipt by Contractor unless additional time is approved in writing by Engineer.**

F. **Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than three (3) submittals. Engineer will record Engineer's time for reviewing submittals subsequent to the third submittal and Contractor shall reimburse Owner for Engineer's charges for such time.**

G. **In the event Contractor requests a substitution for a previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time.**

6.18 *Continuing the Work*

- A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 - 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 - 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
 - 1. observations by Engineer;
 - 2. recommendation by Engineer or payment by Owner of any progress or final payment;
 - 3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 - 4. use or occupancy of the Work or any part thereof by Owner;
 - 5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;
 - 6. any inspection, test, or approval by others; or
 - 7. any correction of defective Work by Owner.

6.20 *Indemnification*

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

- B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.
- C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
 - 1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
 - 2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.
- B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, ~~provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.~~
- D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

- E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

- A. Owner may perform other work related to the Project at the Site with Owner's employees, or through other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:
- ~~1. written notice thereof will be given to Contractor prior to starting any such other work; and~~
 - ~~2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.~~
- B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work **with theirs, in accordance with Section 7.02.** Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.
- C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:
1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
 2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

- A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.
- B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.
- C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

7.04 *Damage to Work of Another Contractor*

- A. *Should Contractor cause damage to the work or property of any other contractor at the Site, or should any claim arising out of Contractor's performance of the Work at the Site be made by any other contractor against Owner or Engineer, Contractor shall promptly attempt to settle with such contractor by agreement, or otherwise resolve the dispute by mediation or at law.*

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

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

8.02 *Replacement of Engineer*

- A. In case of termination of the employment of Engineer, Owner shall appoint an engineer ~~to whom Contractor makes no reasonable objection~~, whose status under the Contract Documents shall be that of the former Engineer.

~~8.03 *Furnish Data*~~

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

~~8.04 *Pay When Due*~~

- ~~A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.~~

~~8.05 *Lands and Easements; Reports and Tests*~~

- ~~A. Owner's duties with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.~~

~~8.06 *Insurance*~~

- ~~A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 5.~~

~~8.07 *Change Orders*~~

- ~~A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.~~

~~8.08 *Inspections, Tests, and Approvals*~~

- ~~A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.~~

8.03 *Limitations on Owner's Responsibilities*

- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

~~8.04 *Undisclosed Hazardous Environmental Condition*~~

- ~~A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.~~

8.04 *Evidence of Financial Arrangements*

- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.05 *Compliance with Safety Program*

- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.

ARTICLE 9 – ENGINEER’S STATUS DURING CONSTRUCTION

9.01 *Owner’s Representative*

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

9.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor’s executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer’s efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer’s visits and observations are subject to all the limitations on Engineer’s authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer’s visits or observations of Contractor’s Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor’s means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

- A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph ~~9.09~~, **9.08**. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer’s consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

- A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or

Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

- A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

~~9.06 *Shop Drawings, Change Orders and Payments*~~

- ~~A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.~~
- ~~B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.~~
- ~~C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.~~
- ~~D. In connection with Engineer's authority as to Applications for Payment, see Article 14.~~

9.06 *Determinations for Unit Price Work*

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

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

- A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within ~~30~~ **seven (7)** **calendar** days of the event giving rise to the question.
- B. Engineer will, ~~with reasonable promptness,~~ **within seven (7) days,** render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

- C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.
- D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.08 *Limitations on Engineer's Authority and Responsibilities*

- A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.
- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with, the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.09 *Compliance with Safety Program*

- A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, **unilaterally** order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive, **including, but not limited to, variations in quantities between estimated and actual quantities**. Upon receipt of any such document, Contractor shall

promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

- B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.D.

10.03 *Execution of Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:
 - 1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;
 - 2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and
 - 3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

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

10.05 *Claims*

- A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may

otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

- B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract ~~promptly (but in no event later than 30 days)~~ **within seven (7) calendar days** after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within ~~60~~ **thirty (30)** days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Times shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written **statement certification** that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within ~~30~~ **twenty (20)** days after receipt of the claimant's last submittal (unless Engineer allows additional time).
- C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:
1. deny the Claim in whole or in part;
 2. approve the Claim; or
 3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.
- D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.
- E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.
- F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in **strict** accordance with this Paragraph 10.05 **and failure to submit such Claim in strict accordance with this Paragraph 10.05 shall be deemed a WAIVER of such Claim.**

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

- A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an

adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, ~~bonuses~~, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.
2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.
3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.
4. **If prior written approval by Owner is obtained, costs** ~~Costs~~ of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. **If prior written approval by Owner is obtained, the** ~~The~~ proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost,

less market value, of such items used but not consumed which remain the property of Contractor.

- c. Rentals of all construction equipment and machinery, and the parts thereof ~~whether rented from Contractor or others~~ in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
- d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
- e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.
- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

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

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, 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 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.
2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
 4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
 5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A.
- C. *Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.
- D. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 Allowances

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. *Cash Allowances:*
1. Contractor agrees that:
 - a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 - b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. *Contingency Allowance:*
1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 *Unit Price Work*

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:
 1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
 2. there is no corresponding adjustment with respect to any other item of Work; and
 3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05. **No change in the Contract Price will be approved for defective pricing upon Bid submission and award, or errors in bidding.**
- B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:
 1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee*: The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or
2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;
 - b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;
 - c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;
 - d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;
 - e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
 - f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

- A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.
- B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.
- D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.
- E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

- A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise

them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

- A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
 - 1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
 - 2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and
 - 3. as otherwise specifically provided in the Contract Documents.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.
- E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.
- F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

- A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.
- B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

- C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.
- D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

- A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).
- B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or
 2. correct such defective Work; or
 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.
- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

- A. If Contractor fails within ~~a reasonable time~~ **fourteen (14) calendar days** after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after ~~seven~~ **fourteen (14) calendar** days written notice to Contractor, correct, or remedy any such deficiency. **If additional time is required due to unforeseen circumstances, a written notice is required detailing the circumstances and delay within seven (7) days of written notice from Engineer.**
- B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.
- C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

- A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 Progress Payments

A. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. Review of Applications:

1. Engineer will, within ~~10~~ **fourteen (14) calendar** days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
 - a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work, or
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:
 - a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
 - d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due:*

1. ~~Ten~~ **Thirty (30)** days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment:*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:
 - a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;
 - b. Liens (**whether or not permissible**) have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
 - c. there are other items entitling Owner to a set-off against the amount recommended **including but not limited to liquidated damages**; or
 - d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.
2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

14.03 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the

Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a **tentative preliminary** certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a **definitive final** certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.
- E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 *Partial Utilization*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
 - 1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.
 - 2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

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

14.07 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.
2. The final Application for Payment shall be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;
 - b. consent of the surety, if any, to final payment;
 - c. a list of all Claims against Owner that Contractor believes are unsettled; and
 - d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or

receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. Engineer's Review of Application and Acceptance:

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due:

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

- A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

- A. The making and acceptance of final payment will constitute:
1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 Owner May Suspend Work

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 Owner May Terminate for Cause

- A. The occurrence of any one or more of the following events will justify termination for cause:
 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);
 2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;
 3. Contractor's repeated disregard of the authority of Engineer; or
 4. Contractor's violation in any substantial way of any provisions of the Contract Documents.
- B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:
 1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);
 2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and
 3. complete the Work as Owner may deem expedient.
- C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such

unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

- D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.
- E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.
- F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

15.03 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;
 - 3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and
 - 4. reasonable expenses directly attributable to termination.
- B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on

any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

- A. **In accordance with N.C.G.S. § 143-128(f1), Owner and Contractor agree to use the dispute resolution process adopted by the North Carolina State Building Commission pursuant to G.S. 143-135.26(11). This dispute resolution process will be available to all parties involved in the Project including Owner, Architect, Contractor, and the first-tier and lower-tier Subcontractors, and it shall be available for any issues arising out of the Contract or construction process, provided that the amount in controversy is \$15,000 or more. Contractor shall make this process available to its Subcontractors by inclusion of this provision in the Subcontractor agreements. Costs of the process will be divided between the parties to the dispute with at least one-third of the cost to be paid by Owner, if Owner is a party to the dispute. Participation in mediation concerning a dispute shall be a precondition to initiating litigation concerning the dispute.** Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. ~~The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement.~~ The request for mediation shall be submitted in writing to the ~~American Arbitration Association and the~~ other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.
- B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:
- ~~1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or~~
 1. agrees with the other party to submit the Claim to another dispute resolution process; or

2. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
 1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or
 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

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

17.03 *Cumulative Remedies*

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

17.04 *Survival of Obligations*

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

17.05 *Controlling Law*

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

17.06 *Headings*

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

17.07 E-Verify

A. E-Verify is the federal program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program, used to verify the work authorization of newly hired employees pursuant to federal law. Contractor shall ensure that Contractor and any Subcontractor performing work under this Contract: (i) uses E-Verify if required to do so; and (ii) otherwise complies with applicable law.

17.08 Iran Divestment Act

A. Pursuant to Article 6E of Chapter 147 of the North Carolina General Statutes, Owner must require most entities with which it contracts, which would include Contractor under this Contract, to certify that the entity is not identified on a list created by the State Treasurer pursuant to N.C.G.S. § 147-86.58 (the "Final Divestment List"). This requirement is related to ensuring that entities with which local governments contract are not involved in investment activities in Iran. Contractor certifies that: (i) it is not listed on the Final Divestment List, and (ii) it will not utilize any Subcontractor performing work under this Contract which is listed on the Final Divestment List.

17.09 Confidentiality

A. Contractor warrants and represents that Contractor shall not knowingly or negligently communicate or disclose at any time to any person or entity any information in connection with the Work or the Project (including, without limitation, information containing specific details of public security plans and arrangements or the detailed plans and drawings of public buildings and infrastructure facilities), except (i) with prior written consent of Owner, (ii) information that was in the public domain prior to the date of this Agreement, (iii) information that becomes part of the public domain by publication or otherwise not due to any unauthorized act or omission of Contractor, or (iv) as may be required to perform the Work by any applicable law, including any set of Drawings, Specifications, and other documents which Contractor is permitted to retain. Specific information shall not be deemed to fall within the scope of the foregoing exceptions merely because it is embraced by more generic information which falls within the scope of one or more of those exceptions. Contractor shall not disclose to others that specific information was received from Owner even though it falls within the scope of one or more of those exceptions. Contractor acknowledges and agrees that the existence of the Owner's particular interests and plans in the geographical area of the Project is a type of such specific information. In the event that Contractor is required by any court of competent jurisdiction or legally constituted authority to disclose any such of Owner's information, prior to any disclosure thereof, Contractor shall notify Owner and shall give Owner the opportunity to challenge any such disclosure order or to seek protection for those portions that it regards as confidential.

17.10 Severability

A. The provisions hereof are severable, and should any provision be determined to be invalid, unlawful or otherwise null and void by any court of competent jurisdiction, the other

provisions shall remain in full force and effect and shall not thereby be affected unless such ruling shall make further performance hereunder impossible or impose an unconscionable burden upon one of the parties. The parties shall endeavor in good faith to replace the invalid, illegal, or unenforceable provisions with valid provisions the economic effect of which comes as close as practicable to that of the invalid, illegal, or unenforceable provisions.

17.11 Minority Participation

A. — Because the Project entails the construction, alteration, erection, or repair of a building, Contractor shall comply with the requirements of the Guidelines for Recruitment and Selection of Minority Businesses for Participation in Union County Construction Contracts and with the representations made in the various affidavits provided pursuant to these Guidelines, such documents having been incorporated into the Contract by reference.

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SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2007 Edition). All provisions that are not so amended or supplemented remain in full force and effect.

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 thereto.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-4.02 *Subsurface and Physical Conditions*

SC 4.02 Delete Paragraphs 4.02.A and 4.02.B in their entirety and insert the following:

- A. No reports of explorations or tests of subsurface conditions at or adjacent to the Site, or drawings of physical conditions relating to existing surface or subsurface structures at the Site, are known to Owner.**

SC-4.06 *Hazardous Environmental Conditions*

SC 4.06 Delete Paragraphs 4.06.A and 4.06.B in their entirety and insert the following:

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

ARTICLE 6 – CONTRACTOR’S RESPONSIBILITIES

SC-6.02 *Labor; Working Hours*

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

- 1. Regular working hours are defined as, Monday through Friday, excluding Owner’s legal holidays, between the hours of 7:00 am and 6:00 pm. 2. Owner's legal holidays are:**
 - a. New Year’s Day**
 - b. Martin Luther King, Jr.’s Birthday**
 - c. Good Friday**
 - d. Memorial Day**
 - e. Independence Day**
 - f. Labor Day**
 - g. Veterans Day**
 - h. Thanksgiving Day**
 - i. Day after Thanksgiving**

- j. Christmas Eve
- k. Christmas Day
- l. Day after Christmas

ARTICLE

ARTICLE 8 – OWNER’S RESPONSIBILITIES

SC-8.06 Add the following new paragraph immediately after Paragraph 8.05 of the General Conditions:

SC-8.06 Owner will furnish an “Owner’s Site Representative” to represent Owner at the Site and assist Owner in observing the progress and quality of the Work. The Owner’s Site Representative is not Engineer’s consultant, agent, or employee.

ARTICLE 9 – ENGINEER’S STATUS DURING CONSTRUCTION

SC-9.03 Project Representative

SC-9.03 Add the following new paragraphs immediately after Paragraph 9.03.A:

- B.** The Resident Project Representative (RPR) will be Engineer’s representative at the Site, will act as directed by and under the supervision of Engineer, and will confer with Engineer regarding RPR’s actions.
 - 1.** General: RPR’s dealings in matters pertaining to the Work in general shall be with Engineer and Contractor. RPR’s dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor. RPR shall generally communicate with Owner only with the knowledge of and under the direction of Engineer.
 - 2.** Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.
 - 3.** Conferences and Meetings: Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.
 - 4.** 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 proper execution of the Work.
 - 5.** Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed

and transmit to Contractor clarifications and interpretations as issued by Engineer.

6. **Shop Drawings and Samples:**
 - a. Record date of receipt of Samples and Contractor-approved Shop Drawings.
 - b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.
 - c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.
7. **Modifications:** Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.
8. **Review of Work and Rejection of Defective Work:**
 - a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Report to Engineer whenever RPR believes that any part of Contractor's work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.
9. **Inspections, Tests, and System Start-ups:**
 - a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's personnel, and that Contractor maintains adequate records thereof.
 - b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.
10. **Records:**
 - a. Prepare a daily report or keep a diary or log book, recording Contractor's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.

- b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.
- c. Maintain records for use in preparing Project documentation.

11. Reports:

- a. Furnish to Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.
- b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.
- c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.

12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:

- a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.
- b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and Contractor, and prepare a final punch list of items to be completed and deficiencies to be remedied.
- c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

C. The RPR shall 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 Contractor's work.
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. Accept Shop Drawing or Sample submittals from anyone other than Contractor.
8. Authorize Owner to occupy the Project in whole or in part.

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Work Change Directive No.

Date of Issuance: _____ Effective Date: _____
 Owner: **UNION COUNTY** Owner's Contract No.: _____
 Contractor: _____ Contractor's Project No.: _____
 Engineer: _____ Engineer's Project No.: _____
 Project: SP105 Crooked Creek WRF Process Contract Name: _____
 Improvements

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: _____

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Change Order

No. _____

Date of Issuance: _____ Effective Date: _____

Project : SP105 Crooked Creek WRF Process Improvements	Owner: UNION COUNTY	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

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

Description:

Attachments (list documents supporting change):

CHANGE IN CONTRACT PRICE:

CHANGE IN CONTRACT TIMES:

Original Contract Price:

\$ _____

Current Contract Price:

\$ _____

Contract Contingency:

\$ _____

Current Available Contingency:

\$ _____

Amount of this Change Order:

\$ _____

Change Order to be Funded Through:

Contingency Contract Price

Contingency Incorporating this Change Order:

\$ _____

Contract Price Incorporating this Change Order:

\$ _____

Original Contract Times: Working Calendar Days
Days

Substantial completion (days or date): _____

Ready for final payment (days or date): _____

Increase Decrease from previously approved Change Orders
No. _____ to No. _____:

Substantial completion (days): _____

Ready for final payment (days): _____

Contract Times Prior to this Change Order:

Substantial Completion (Days or Date): _____

Ready for Final Payment (Days or Date): _____

Increase Decrease of this Change Order:

Substantial Completion Date (Days or Date): _____

Ready for Final Payment (Days or Date): _____

Contract Times with all approved Change Orders:

Substantial completion (days or date): _____

Ready for final payment (days or date): _____

RECOMMENDED:

By: _____

Engineer (Authorized Signature)

Date: _____

Approved by Funding Agency

(if applicable): _____

ACCEPTED:

By: _____

Owner (Authorized Signature)

Date: _____

ACCEPTED:

By: _____

Contractor (Authorized Signature)

Date: _____

Date: _____

Change Order

Instructions

A. GENERAL INFORMATION

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

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

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

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

B. COMPLETING THE CHANGE ORDER FORM

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

Field Order

No. _____

Date of Issuance: _____ Effective Date: _____

Project: SP105 Crooked Creek WRF Process Improvements	Owner: UNION COUNTY	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

Attention:

You are hereby directed to promptly execute this Field Order issued in accordance with General Conditions Paragraph 9.04.A, for minor changes in the Work without changes in Contract Price or Contract Times. If you consider that a change in Contract Price or Contract Times is required, please notify the Engineer immediately and before proceeding with this Work.

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

Description:

Attachments:

Engineer:

Receipt Acknowledged by Contractor: _____ Date: _____

Copy to Owner

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SALES TAX REPORT

CONTRACTOR NAME:
 CONTRACTOR ADDRESS:
 PROJECT NAME: SP105 Crooked Creek WRF Process Improvements

DATE:
 FOR PERIOD OF:

INVOICE DATE	INVOICE No.	VENDOR NAME	TAXABLE AMOUNT OF INVOICE	NC STATE TAX 4.75%	COUNTY TAX	COUNTY NAME	ADDITIONAL MECKLENBURG COUNTY TAX 0.50%	TOTAL TAX	INVOICE TOTAL
				\$ -			\$ -	\$ -	\$ -
				\$ -			\$ -	\$ -	\$ -
				\$ -			\$ -	\$ -	\$ -
				\$ -			\$ -	\$ -	\$ -
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				\$ -			\$ -	\$ -	\$ -
				\$ -			\$ -	\$ -	\$ -
Totals from additional pages:				\$ -			\$ -	\$ -	\$ -
GRAND TOTAL:			\$ -	\$ -	\$ -		\$ -	\$ -	\$ -

I certify that the following is a true and correct summary of North Carolina State and Local taxes paid for materials purchased in connection with the above project.

Subscribed and sworn to before me this _____ day of _____, 20 _____.

By: _____

 Notary Public

My commission expires: _____

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 – GENERAL

1.01 (NOT USED)

1.02 LOCATION AND DESCRIPTION OF WORK

A. The Work is located at the following Site:

1. Crooked Creek Water Reclamation Facility; Sardis Church Road; Union County, NC

B. The Work to be performed under this Contract generally 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. Replacement of existing brush aerators in the Oxidation Tanks with new rotary disc aerators and VFDs.
2. New Scum Pump Stations No. 1 & 2, including submersible chopper pumps, valve vaults, and a 4" Scum force main discharging to Digesters No. 1 & 2 and the Drying Beds. The Work also includes replacement / relocation of the scum troughs in the Secondary Clarifiers.
3. New Sludge Flow Control Vaults No. 1 – 4, including flow meters and modulating plug valve for controlling flow to the Return Sludge Pump Station. The Work also includes piping modifications in the Secondary Clarifiers to allow for connection to these new vaults.
4. New Electrical Canopy (MCC-RAS), to provide power and control equipment / connections to the new facilities as well as some existing facilities. The Electrical Canopy includes VFDs for the disc aerators and the new PLC-RAS.
5. All other discipline work shown on the drawings.

1.03 (NOT USED)

1.04 (NOT USED)

1.05 (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 (NOT USED)

1.08 (NOT USED)

1.09 (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 shown on the Drawings.

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

- 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. N/A.
- 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

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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.

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.
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 ten (10) 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.
 - d. Residuals shall be removed and disposed at a Subtitle D landfill.
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. (Not Used)
 - 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 on the Drawings 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.

1.07 (NOT USED)

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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 (NOT USED)

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 (NOT USED)

END OF SECTION

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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. (Not Used)
 - c. Field Orders
 - d. Work Change Directives
 - e. Proposal requests
 - f. Change Proposals
 - g. 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

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 (NOT USED)

1.05 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".
4. Engineer will maintain a log of Field Orders issued.

B. Procedure.

1. (Not Used)
2. Electronic copies of Field Orders will be maintained, stored, and distributed by electronic construction document management system.
3. 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.
4. If the Field Order is unclear, submit request for interpretation.

1.06 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".

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. (Not Used)
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.

1.07 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
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.

1.08 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
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.

1.09 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".

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. (Not Used)
4. 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

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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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.
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 three percent of total cost of each item (including overhead and profit), including materials and equipment, and installation, may be apportioned to testing and included in the Application for Payment following Engineer's acceptance of the associated written Site testing report(s).
- 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. Three copies of preliminary Schedule of Values.
2. Three 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.

1.02 ADMINSTRATIVE 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 Engineer quantities and the Work proposed for inclusion in each progress payment. Application for Payment shall cover only the Work and quantities recommended by the Engineer.
 - 2. Submit to Engineer three 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.

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) 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.
 - b. Owner.
 - c. Engineer.
 - d. Union Power representative.
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).
 - 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) (Not Used)
 - 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. 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.
5. 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. Contractor shall prepare and submit Progress Schedules and related documents in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section, unless otherwise accepted by Engineer.
 - 1. Maintain and update Progress Schedules and related documents.
 - 2. Progress Schedule shall be a Critical Path Method (CPM) Progress Schedule.
- B. Engineer's acceptance of the Progress Schedule or related documents, and comments or opinions concerning activities in the Progress Schedule and related documents shall not control independent judgment of Contractor concerning means, methods, techniques, sequences and procedures of construction, unless the associated means, method, technique, sequence, or procedure is directed by the Contract Documents. Contractor is solely responsible for complying with the Contract Times.

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 date an Activity can finish according to the assigned relationships among the Activities.
7. Late Finish: The latest date an Activity can finish without extending the Contract Times.
8. Late Start: The latest date an Activity can start without extending the Contract Times.
9. Float: The time difference between the calculated duration of the Activity chain and the Critical Path.
10. Total Float: The total number of days that an Activity (or chain of Activities) can be delayed without affecting the Contract Times.
11. Network Diagram: A time-scaled logic diagram depicting the durations and relationships of the Activities.
12. 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 scheduling software that is acceptable to Engineer.
 - b. Sheet Size: 11" by 17", unless otherwise accepted by Engineer.
 - c. Time Scale: Indicate first date of each work week.
 - d. Activity Designations: Indicate title and related Specification Section number.
 - e. Organization:
 - 1) Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, Samples, and other submittals.
 - 2) Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
 - 3) Group construction into Work Area sub-schedules (that are part of the Progress Schedule) by Activity.

- 4) Clearly indicate the Critical Path on the Progress Schedule.
 - 5) Organize each Work Area sub-schedule by Specification Section number.
2. Preliminary Progress Schedule:
- a. Contractor shall submit to Engineer the preliminary Progress Schedule with associated Network Diagrams within 15 days after the Contract Times commence running.
3. 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 and associated Network Diagram.
 - 3) Owner reserves the right to not make progress payment to Contractor until acceptable Progress Schedule, Network Diagram, and other reports and schedule-related documents required are submitted to Engineer.
 - b. Submit 3 copies each of acceptable Progress Schedule with Network Diagram, reports, and other schedule-related documents required to accompany the initial acceptable Progress Schedule, in accordance with the Submittals Article of this Section.
 - c. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.

B. Progress Schedule Updates:

1. Update the Progress Schedule each month. If during progress of the Work events develop that necessitate changes in the initially accepted Progress Schedule (i.e., baseline Progress Schedule), identify updated Progress Schedules sequentially as Progress Schedule Revision 1, 2, 3, and continuing in sequence as required.
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. Submit to Engineer 3 hard copies of the updated Progress Schedule, Network Diagram, narrative report, and other schedule-related reports and documents required.
5. Submit updated Network Diagrams when revisions are proposed to the logic. Indicate in the narrative report delays that have occurred since the previous updated Progress Schedule. Engineer will not recommend payment by Owner of progress payments until updated Progress Schedule is received, reviewed, and accepted by Engineer. Payment for out-of-sequence Work is not allowed.

1.04 NETWORK DIAGRAMS (PERT CHARTS)

A. General:

1. Contractor shall prepare and submit Network Diagrams, as generated using the scheduling software on paper of the size indicated for Progress Schedules in this Section.
2. Group Network Diagrams by Area and show the order and interdependence of Activities and sequence and quantities in which the Work will be accomplished.
3. Do not use match lines on Network Diagrams. Depict interrelationships to or from Activities outside the Area shown using an Activity symbol with Activity number and description.
4. In preparing Network Diagrams, comply with the basic concept of precedence diagramming method (PDM) network scheduling to show how start of a given Activity depends on completion of preceding Activities, and how the Activity's completion may affect the start of subsequent Activities.
5. Level of schedule detail shall define the day-to-day Activities of the Work.

B. Content:

1. Clearly indicate the Critical Path and distinguish the Critical Path from other paths on the network.
2. Organize Network Diagrams by grouping into major Work Areas, including one for procurement of materials and equipment, and by specific Activity within each Area.
3. Logic diagrams shall include the following:
 - a. Activity number.

- b. Activity description.
- c. Activity duration (in work days).
- d. Critical Path denoted.
- e. Float for each Activity.
- f. Activity or System designation.
- g. Coded Area designation.
- h. Responsibility code (e.g., each prime contractor and their respective Subcontractors, trade, operation, Suppliers, or other entity responsible for accomplishing an Activity).
- i. Shift number (if more than one shift per day is to be employed).

C. Revisions:

- 1. When conditions develop that require revisions to logic or durations of the Network Diagram associated with the initially accepted Progress Schedule (i.e., baseline Progress Schedule), identify updates to the Network Diagram in the same manner required in this Section for Progress Schedule updates.
- 2. Revision of the logic or durations from the baseline Progress Schedule initially accepted by Engineer shall be submitted to Engineer for acceptance.
- 3. Incorporate into the Progress Schedule revisions to logic or duration accepted by Engineer and include in monthly narrative report both a description of revisions and listing of Activities affected by revisions.
- 4. Changes resulting from Change Orders and other additions or deletions, shall be fully incorporated into the Progress Schedule and Network Diagram on the first update after the associated Change Order is approved by Owner, including adjustments to the Contract Price.

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 in the Network Diagram.
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. 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 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 recovery 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 with associated Network Diagrams.
 - b. Acceptable Progress Schedule with associated Network Diagrams.
 2. Progress Schedule Updates:

- a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule, updated Network Diagram when relationships among Activities are changed.
 - 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

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 his obligations under the Contract Documents relative to that submittal.

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, potential Hazardous Environmental Condition, 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, unless otherwise specified in individual Specification Sections. Acceptable electronic formats are Adobe PDF, Microsoft Word, Autodesk DWF and AutoCAD.
- 2. (NOT USED).
- 3. 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.

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.
 - 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 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.
- C. Contractor shall provide written notice of deviations or variations that submittal may have with the Contract Documents.
- D. 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.
- E. 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)

END OF SECTION

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 (AFBMA))
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
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.
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

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SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 – GENERAL

1.01 SUMMARY

A. Contractor shall provide temporary utilities required for the Project and to complete the Work.

1. Make arrangements with utility service companies for temporary services and obtain required permits and approvals for temporary utilities.
2. Pay utility service costs, including connection fees, required for the Work as needed.
3. Continuously maintain adequate utilities for all purposes during the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities through Substantial Completion and removal of temporary field offices and sheds.
4. (Not Used)
5. Maintain, including cleaning, temporary utilities and continuously provide consumables as required.
6. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and requirements of Project.
7. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.

B. Provide the following temporary utilities:

1. Electricity and lighting.
2. Telephone and communications.
3. Heating.
4. Sanitary facilities.
5. Water service.
6. First-aid facilities.

7. Fire protection.
8. Project-Specific items as shown on the Drawings.

1.02 ADMINSTRATIVE REQUIREMENTS

A. Use of Owner's System:

1. Existing Utility Systems: Do not use systems in existing buildings or structures for temporary utilities without Owner's written permission and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between Owner and Contractor.
2. Use of Permanent Utility Systems Provided Under the Project:
 - a. Permanent lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
 - 1) Obtain Owner's written permission to use permanent systems.
 - 2) Permanent systems to be used for temporary utilities or temporary facilities shall have achieved Substantial Completion, including complete functionality of all controls.
 - 3) Contractor shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
 - b. Do not use the following permanent facilities:
 - 1) Telephone and communication facilities.
 - 2) Sanitary facilities.

1.03 SYSTEM DESCRIPTION

A. Electricity and lighting:

1. Contractor shall provide electrical and lighting service for construction field offices, sheds, storage containers, etc. and as required for the Work.
2. General 120/240 V service requirements:
 - a. Contractor shall provide 120/240 V, single phase, 3-wire temporary system for small power requirements and general lighting.

- b. Contractor shall provide main disconnect, overcurrent protection, meter outlet, branch circuit breakers, and wiring for temporary service to the Contractor's field office service connections. Contractor shall provide equipment and appurtenances in accordance with electricity service provider and applicable standards and codes
 - c. Contractor shall register the 120/240 V electrical service meter in the Contractor's name and shall be responsible for electrical charges at no additional cost to the Owner.
 - d. Contractor shall provide electrical service other than 120/240 V, single phase, 3-wire service as required for the Work at the Contractor's own expense.
3. General lighting requirements:
- a. Contractor shall provide a minimum of 10 foot candles for enclosed and partially enclosed structures for performing the Work.
 - b. Contractor shall provide a night lighting circuit for security. Light intensity shall be a minimum of 2 foot candles.
4. Contractor shall energize the electrical system 15-minutes prior to and following regular work day hours at the Site. Required from Monday through Friday, all inclusive.
5. Contractor shall energize the night lighting system at end of typical working day and de-energize at start of typical working day. System shall be continuously energized on Saturdays, Sundays, and holidays.
6. Contractor shall provide an independent grounding cable connected directly to the structure, building, and equipment for erection and fabrication by electrical welders. Grounding by adjacent conduit, piping, etc. shall be prohibited at the Site.
7. Contractor shall coordinate usage of temporary electrical system with Subcontractors, Suppliers, and Owner including the following:
- a. Usage is suitable for 120V, single phase, 60 Hz operation with a maximum operating input of 1,500 volt-amperes.
 - b. One unit connected to a single outlet.
 - c. Restrict usage in case of overloading circuits to correct loading.
- B. Telephone and communications: Contractor shall provide temporary telephone and communications required for its operations at the Site and for summoning emergency medical assistance.

C. Heating:

1. Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to protect the Work and materials against wetness and temperature damage, to dry out the Work, and to facilitate the Work in structures.
2. Equipment, fuel, materials, personnel and methods used shall be adequate to maintain critical installation temperatures and ventilation of Work at all times in areas where necessary to perform the Work.
3. Enclosed structures shall have a minimum temperature of 50°F, unless otherwise specified, where Work is performed.
4. Contractor shall provide sufficient heat to maintain a minimum temperature of 65°F before and during application of interior finishing, painting, coating, etc.
5. Contractor shall replace any Work damaged by dampness or insufficient/abnormal heating at no cost to the Owner.

D. Sanitary facilities:

1. Contractor shall provide suitably-enclosed chemical or self-contained toilets for Contractor's employees and visitors to the Site. Location of temporary toilets shall be acceptable to Owner and screened from public observation.
2. Facilities shall be maintained and provided in accordance with State or Commonwealth Labor Regulations and local ordinances. Contents shall be removed and disposed in accordance with local and state or commonwealth regulations as required.
3. Contractor shall be prohibited from committing nuisances within, on, or in the vicinity of the Site.

E. Water service:

1. Contractor shall provide temporary water service for the Work including for construction purposes, sanitary facilities, fire protection, field office, and cleaning purposes.
2. Contractor shall provide potable water for Contractor's personnel either by portable containers or drinking fountains.
3. Contractor shall provide temporary hose bibs, hoses, and watertight barrels for the distribution of water.
4. Contractor shall provide freeze protection for water service.

F. First-aid facilities:

1. Contractor shall provide temporary first-aid stations at or immediately adjacent to the Site's major work areas. Contractor shall provide temporary first-aid stations inside its temporary field office. Locations of first-aid stations shall be determined by Contractor's safety representative.
2. Contractor shall provide list of emergency telephone numbers.

G. Fire protection:

1. Contractor shall comply with NFPA 241, Safeguarding Building Construction, Alteration, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.
2. Contractor shall provide temporary fire exits, fire extinguishers, hoses and safety devices as required by authorities having jurisdiction.
3. Contractor shall notify Engineer, Owner, and fire marshals in the event of fire at the Site including, but not limited to, fuel tanks and similar hazardous utilities and devices. Contractor shall cooperate with Owner of fuel tank and utilities to prevent occurrence of fire or explosion.
4. Contractor shall perform safety precautions and comply with fire marshal's instructions in the event of fire.

PART 2 – PRODUCTS

2.01 EQUIPMENT

- A. Materials and equipment for temporary systems may be new or used but shall be adequate for purposes intended and shall not create unsafe conditions and shall comply with Laws and Regulations.
- B. Provide required materials, equipment, and facilities, including piping, wiring, and controls.
- C. Electrical system requirements: System shall consist of wiring, switches, insulated supports, poles, fixtures, sockets, receptacles, lamps, guards, cutouts and fuses as required for completion of the Work.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of Temporary Utilities and Temporary Facilities:

1. Locate temporary systems for proper function and service.
2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.
3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.

C. Modify and extend temporary systems as required by progress of the Work.

3.02 MAINTENANCE

A. Maintain temporary systems to provide safe, continuous service as required.

B. Properly supervise operation of temporary systems:

1. Enforce compliance with Laws and Regulations.
2. Enforce safe practices.
3. Prevent abuse of services.
4. Prevent nuisances and hazards caused by temporary systems and their use.
5. Prevent damage to finishes.
6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

D. Contractor shall replace broken and burned out lamps, blown fuses, and damaged wiring and appurtenances as required to maintain adequate and safe operating conditions.

E. Contractor shall permit subcontractors and others at a mutually agreed arrangement to use temporary electrical system that meet the following requirements:

1. Equipment are suitable for 120 V, single phase, 60 Hz operation.
2. Operating input does not exceed 1,500 volt-amperes.
3. Single piece of equipment connected to one outlet.

4. Contractor shall restrict use of equipment as required to prevent overloading circuits.

3.03 CLOSEOUT ACTIVITES

- A. Completely remove temporary utilities, facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.
- B. Contractor is responsible for and shall return to original condition those portions of permanent electric system used in completing the Work.
- C. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.
- D. When permanent utilities and systems that were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

END OF SECTION

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SECTION 01 52 00
CONSTRUCTION FACILITIES

PART 1 – GENERAL

1.01 SUMMARY

- A. Contractor shall provide construction facilities for performance of the Work, including the following:
 - 1. Contractor's field office, sheds, and storage containers that shall be erected within 30 days of Notice to Proceed on the Project.
 - 2. (Not used)
 - 3. Project sign and panel that shall be erected within 21 days of Notice to Proceed on the Project.

1.02 FACILITY DESCRIPTION

- A. Contractor's Field Office, Sheds, and Storage:
 - 1. Contractor shall provide and maintain a field office at the Site, including temporary utility services specified.
 - a. Field office shall include one room / office space for Engineer's construction observers to use when onsite.
 - 2. Size and Furnishings: As required by Contractor
 - 3. Features: Exterior Contractor identification sign, night lighting for security, and temporary utilities specified in Section 01 51 00 – Temporary Utilities.
 - 4. Location: As shown on the Contract Documents.
 - 5. Contractor shall provide and maintain one set of Contract Documents, latest approved Shop Drawings, Field Orders, request for interpretations, clarification notices, Work Change Directives, proposal requests, Change Proposals, Change Orders, and other pertinent Project related correspondence.
- B. (Not Used)
- C. Project Identification Sign:
 - 1. Contractor shall provide in accordance to this Section.

2. Contractor shall maintain project identification sign for the duration of the Contract.
3. Contractor shall remove and dispose of project identification sign at the completion of the Project when notified by the Engineer.
4. Contractor shall not receive additional payment for deterioration or replacement of names and other pertinent sign information throughout the duration of the Project.

1.03 SUBMITTALS

- A. Action/Informational Submittals: Project identification sign layout, details, and materials of construction.

PART 2 – PRODUCTS

2.01 COMPONENTS

- A. Project Identification Sign
 1. Sign Panel: 3/4-inch thickness (minimum) marine plywood rabbeted in a 2" x 4" wood frame. Panel shall be fastened to sign supports with six 3/8" dia galvanized bolts, nuts and washers (minimum).
 2. Sign Supports: Two, 4" x 4" treated wood posts.
 3. Fasteners and Hardware: Galvanized
 4. Painting: Supports, trim and back of sign panel shall be painted with two coats (minimum) of same paint for sign face. Paint shall be exterior grade paint, suitable for wood application and in accordance with Section 09 90 00 – Painting.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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 directed by the Owner.
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.
 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 will be directed by the Owner. 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 61 00
PRODUCT REQUIREMENTS AND OPTIONS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Common requirements for products.
2. Contractor's options for selecting products.
3. Requirements for consideration of "or equal" products.
4. Warranty requirements of products.

1.02 REFERENCES

A. Definitions:

1. "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.
2. "Special Warranties" includes additions or modifications to standard warranty requirements specified in the Contract Documents.

1.03 SUBMITTALS

A. Warranty Log Book:

1. Submit warranty log book prepared specifically for this Project. Submittal shall include a summary listing of all equipment and material warranties furnished in the Contract, date received, and start/end date of warranty period. Individual warranty documentation shall be provided in the submittal.
2. Submit prior to submittal of final application for payment.

B. Patent Documentation: Submit licensing arrangement and agreement documentation.

1.04 REQUIREMENT

A. Common Products:

1. Provide products that have not been previously incorporated into another project or facility unless otherwise indicated in the Contract Documents.
2. To the extent possible, provide products of the same generic kind from a single source.
3. Provide products complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.
4. Standard Products: When available, and unless custom or nonstandard options are specified or indicated, provide standard products of types that have been produced and used successfully in similar situations on other projects.
5. Visual Matching: Where required in the Contract Documents, provide products that match referenced existing construction, approved mock-ups, or approved Sample, as determined by Engineer.
6. Where the Contract Documents include the phrase “as selected” for product color, finish pattern, option, or similar phrase, provide products selected by Engineer as follows:
 - a. Standard Range: Where the Contract Documents include the phrase “standard range of colors, patterns, textures” or similar phrase, provide color, pattern, density, or texture selected by Engineer from manufacturer’s product line that does not include premium items.
 - b. Full Range: Where the Contract Documents include the phrase “full range of colors, patterns, textures” or similar phrase, Engineer will select color, pattern, density, or texture from manufacturer’s entire product line, including standard and premium items.

B. Product Compatibility:

1. Similar products by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents or approved by Engineer.
2. Provide products compatible with products previously selected or installed on the Project.

C. Product Options:

1. For products specified only by reference standard or description, without reference to Supplier, provide products meeting that standard, by a Supplier or from a source that complies with the Contract Documents.

2. For products specified by naming one or more products or Suppliers, provide the named products that comply with the Contract Documents, unless an “or equal” or substitute product is approved by Engineer.
3. For products specified by naming one or more products or Suppliers and the term, “or equal”, when Contractor proposes a product or Supplier as an “or equal”, submit to Engineer a request for approval of an “or equal” product or Supplier.
4. For products specified by naming only one product or manufacturer and followed by words indicating that no substitution is allowed, there is no option and no substitution will be allowed.

D. Concerning Patents:

1. Owner shall be provided a guarantee by Contractor and equipment Supplier that equipment and material furnished in accordance with the Contract Documents is not the subject of patent litigation.
2. Patent litigation or controversy shall include, but not limited to, the following:
 - a. Actual furnished equipment and material the is subject or could be subject to patent litigation or is known to infringe on a patent.
 - b. Furnished equipment and material that may result in a process that use of equipment and material in a manner that infringes upon or violates a patent.
3. When patent infringement may occur, Contractor and Supplier shall submit license arrangements among parties, including Contractor, Supplier, and patent owner (controller of patent) at a minimum, which shall permit use of equipment and material as specified in the Contract Documents.
4. Supplier shall indemnify and hold harmless Owner and Engineer against all claims, costs, losses, and damages arising out of or relating to any infringement or patent rights or copyrights incident to the use of equipment and material specified in the Contract Documents and as required in General Conditions and as modified in the Supplemental Conditions.

E. “Or Equal” Products:

1. For proposed products not named in the Contract Documents and considered as an “or equal” as defined in the General Conditions, Contractor shall request in writing Engineer’s approval of the “or equal”. Request for approval of an “or equal” product shall accompany the Shop Drawing or product data submittal for the proposed product and shall include:

- a. Contractor's request that the proposed product be considered as an "or equal" in accordance with the General Conditions, accompanied by Contractor's certifications required in the General Conditions.
- b. Documentation adequate to show that proposed product does not require extensive revisions to the Contract Documents, that proposed product is consistent with the Contract Documents, and that proposed product will produce results and performance required in the Contract Documents, and that proposed product is compatible with other portions of the Work.
- c. Detailed comparison of significant qualities of proposed product with the products and manufacturers named in the Contract Documents. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements shown or indicated.
- d. Evidence that proposed product manufacturer will furnish warranty equal to or better than specified, if any.
- e. List of similar installations for completed projects with project names and addresses, and names and address of design professionals and owners, if requested.
- f. Samples, if requested.
- g. Other information requested by Engineer.

1.05 WARRANTY

- A. Warranties specified for products shall be in addition to, and run concurrent with, Contractor's general warranty and guarantee and requirements for the required correction period. Disclaimers and limitations in specific product warranties do not limit Contractor's general warranty and guarantee.
 1. Product manufacturer's warranty is preprinted written warranty published by product manufacturer and specifically endorsed by product manufacturer to Owner.
 2. Equipment and material shall be guaranteed to be free from defects in workmanship, design, and/or materials for a period of one (1) year unless otherwise specified in the individual Specification Section for a Special Warranty.
 3. Warranty period shall start on the date of the particular equipment and material is placed in to intended use by the Owner, which includes requirements specified in Section 01 75 00 – Checkout and Startup Procedures for start-up certification and specified elsewhere in the Contract Documents.

4. Warranty requirements may be added to or modified in the individual Specification Sections. Special warranty is written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by product manufacturer's warranty or to provide increased rights to Owner.
 5. Special warranty information, if any, will be located in the Specification Section for that product.
- B. Requirements for Special Warranties: Provide written special warranty document that contains appropriate terms and identification, ready for execution by product manufacturer and Owner. Submit draft warranty with submittals required for product.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed by product manufacturer and other parties as appropriate.
 2. Specified Form: When specified forms are included in the Contract Documents, prepare written document, properly executed by product manufacturer and Owner, using appropriate form.
 3. Refer to Specifications for content and requirements for submitting special warranties.
- C. Submit product manufacturer's warranties and special warranties as submittals in accordance with Schedule of Submittals accepted by Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 65 00
PRODUCT DELIVERY REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for preparing for shipping, delivering, and handling materials and equipment.
2. Contractor shall make all arrangements for transporting, delivering, and handling of materials and equipment required for prosecution and completion of the Work.

1.02 SUBMITTALS

- A. Refer to individual Specification Sections for submittal requirements relative to delivery and handling materials and equipment.

1.03 SHIPMENT REQUIREMENTS

- A. When practical, factory-assemble materials and equipment. Match mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable, protective coating.
- B. Package materials and equipment to facilitate handling, and protect materials and equipment from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate the associated purchase order number, bill of lading number, contents by name, Owner's contract name and number, Contractor name, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.
- C. Protect materials and equipment from exposure to the elements and keep thoroughly dry and dust-free at all times. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Lubricate bearings and other items requiring lubrication in accordance with manufacturer's instructions.
- D. Advance Notice of Shipments:
1. Keep Engineer informed of delivery of all materials and equipment to be incorporated in the Work.
- E. Do not ship materials and equipment until:

1. Related Shop Drawings, Samples, and other submittals have been approved or accepted (as applicable) by Engineer, including, but not necessarily limited to, Submittals associated with the materials and equipment being delivered.
2. Manufacturer's instructions for handling, storing, and installing the associated materials and equipment have been submitted to and accepted by Engineer in accordance with the Specifications.
3. Results of source quality control testing (factory testing), when required by the Contract Documents for the associated materials or equipment, have been reviewed and accepted by Engineer.
4. Facilities required for handling materials and equipment in accordance with manufacturer's instructions are in place and available.
5. Required storage facilities have been provided.

1.04 DELIVERY REQUIREMENTS

A. Scheduling and Timing of Deliveries:

1. Arrange deliveries of materials and equipment in accordance with the accepted Progress Schedule and in ample time to facilitate inspection prior to installation.
 - a. Equipment and material shall not be delivered to the Site prior to 90 days in advance of scheduled installation.
 - b. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are improperly stored.
2. Schedule deliveries to minimize space required for and duration of storage of materials and equipment at the Site or delivery location, as applicable.
3. Coordinate deliveries to avoid conflicting with the Work and conditions at Site, and to accommodate the following:
 - a. Work of other contractors and Owner.
 - b. Storage space limitations.
 - c. Availability of equipment and personnel for handling materials and equipment.
 - d. Owner's use of premises.
4. Deliver materials and equipment to the Site during regular working hours.

5. Deliver materials and equipment to avoid delaying the Work and the Project, including work of other contractors, as applicable. Deliver anchor system materials, including anchor bolts to be embedded in concrete or masonry, in ample time to avoid delaying the Work.

B. Deliveries:

1. Shipments shall be delivered with Contractor's name, Subcontractor's name (if applicable), Site name, Project name, and contract designation clearly marked.
2. Site may be listed as the "ship to" or "delivery" address; but Owner shall not be listed as recipient of shipment unless otherwise directed in writing by Engineer.
3. Provide Contractor's telephone number to shipper; do not provide Owner's telephone number.
4. Arrange for deliveries while Contractor's personnel are at the Site. Contractor shall receive and coordinate shipments upon delivery. Shipments delivered to the Site when Contractor is not present will be refused by Owner, and Contractor shall be responsible for the associated delays and additional costs, if incurred.

C. Containers and Marking:

1. Have materials and equipment delivered in manufacturer's original, unopened, labeled containers.
2. Clearly mark partial deliveries of component parts of materials and equipment to identify materials and equipment, to allow easy accumulation of parts, and to facilitate assembly.

D. Inspection of Deliveries:

1. Immediately upon delivery, Contractor shall inspect shipment to verify that:
 - a. Materials and equipment comply with the Contract Documents and approved or accepted (as applicable) submittals.
 - b. Quantities are correct.
 - c. Materials and equipment are undamaged.
 - d. Containers and packages are intact and labels are legible.
 - e. Materials and equipment are properly protected.
2. Promptly remove damaged materials and equipment from the Site and expedite delivery of new, undamaged materials and equipment, and remedy incomplete or

lost materials and equipment to furnish materials and equipment in accordance with the Contract Documents, to avoid delaying progress of the Work.

3. Advise Engineer in writing when damaged, incomplete, or defective materials and equipment are delivered, and advise Engineer of the associated impact on the Progress Schedule.

1.05 HANDLING REQUIREMENTS

- A. Provide equipment and personnel necessary to handle materials and equipment, including those furnished by Owner, by methods that prevent soiling or damaging materials and equipment and packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring, and otherwise damaging materials and equipment and surrounding surfaces.
- C. Handle materials and equipment by methods that prevent bending and overstressing.
- D. Lift heavy components only at designated lifting points.
- E. Handle materials and equipment in safe manner and as recommended by the manufacturer to prevent damage. Do not drop, roll, or skid materials and equipment off delivery vehicles or at other times during handling. Hand-carry or use suitable handling equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 66 00
PRODUCT STORAGE AND PROTECTION REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

- A. General requirements of storing and protecting equipment and materials.

1.02 STORAGE

- A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents.
- B. Contractor shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment. Construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to Owner, other contractors, public travel, and owners, tenants, and occupants of adjoining property. Arrange storage in manner to allow easy access for inspection.
- C. Areas available at the Site for storing materials and equipment shall be approved in advance by the Owner.
- D. Store materials and equipment to become Owner's property to facilitate their inspection and ensure preservation of quality and fitness of the Work, including proper protection against damage by freezing, moisture, and high ambient temperatures. Store in indoor, climate-controlled storage areas all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements, unless otherwise acceptable to Owner.
- E. Contractor shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
- F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified in the Contract Documents.
- G. Do not store materials or equipment in structures being constructed unless approved by Engineer in writing.
- H. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.

- I. Contractor shall not store unnecessary equipment and materials at the Site, and shall take care to prevent structures from being loaded with a weight that endanger its security and safety of persons.
- J. Stored equipment and materials shall not be placed within 10 feet of fire hydrants. Gutters, drainage channels and inlets shall be kept unobstructed at all times.

1.03 PROTECTION

- A. Contractor shall provide temporary storage containers/facilities, if required, to protect equipment and materials at the Site.
- B. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage, in accordance with Section 01 65 00 – Product Delivery Requirements.
- C. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.
- D. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of Engineer.

1.04 SPECIFIC STORAGE REQUIREMENTS

- A. Uncovered:
 - 1. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
 - a. Piping, except polyvinyl chloride (PVC) or chlorinated PVC (CPVC) pipe.
- B. Covered:
 - 1. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
 - a. Grout and mortar materials.
 - b. Rough lumber.
 - c. PVC and CPVC pipe.
 - 2. Tie down covers with rope, and slope covering to prevent accumulation of water.
- C. Fully Protected:

1. All materials and equipment not named as uncovered or covered in this Section, shall be stored on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully closed walls on all sides. Covering with plastic sheeting or similar material in space without floor, roof, and walls is not acceptable. Comply with the following:
 - a. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
 - b. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures.
 - c. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
 - d. Maintain humidity at levels recommended by manufacturers of electrical and electronic equipment.
 - e. Energize space heaters for electrical equipment and material.
- D. Maintenance of Storage: On scheduled basis, periodically inspect stored materials and equipment to ensure that:
1. Condition and status of storage facilities is adequate to provide required storage conditions.
 2. Required environmental conditions are maintained on continuing basis.
 3. Materials and equipment exposed to elements are not adversely affected.

1.05 RECORDS

- A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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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 his 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 excavation.

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 investigation 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.
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 uninterrupted 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 his Work to structures and facilities.

4. Contractor shall repair immediately damage caused by his 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 equipment 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 rain storms 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 00
EXECUTION OF WORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Contractor shall provide labor, materials, tools, equipment, and incidentals shown, specified, and required for execution of the Work as specified in this Section, including the following:
 - a. Construction Electronic Documentation
 - b. Demolition
 - c. Cutting and Coring
 - d. Patching
 - e. Installation
2. Requirements for demolition, removal and disposal of existing buildings, structures, pavement, curbs, and sidewalks and electrical, plumbing, heating and ventilation equipment and materials as indicated in the Contract Documents for demolition.
3. General requirements for installation of equipment and material. Additional installation requirements are included in the individual Specification Sections.
4. General requirements for connections to existing facilities.
 - a. To extent possible, materials, equipment, systems, piping, and appurtenances that will be placed into service upon completion of connection to existing facilities shall be checked, successfully tested, and in condition for operation prior to making connections to existing facilities, if valves, gates, or similar watertight and gastight isolation devices are not provided at the connection point.
5. Requirements for cutting and coring, and rough and finish patching of holes and openings in existing construction. Provide cutting, coring, fitting and patching, including attendant excavation and fill, required to complete the Work, and to:
 - a. Remove and replace defective Work;

- b. Remove samples of installed Work as specified or required for testing;
- c. Remove construction required to perform required alterations or additions to existing work;
- d. Connect to completed Work not performed in proper sequence;
- e. Remove or relocate existing utilities and pipes that obstruct the Work in locations where connections must be made;
- f. Make connections or alterations to existing or new facilities.

1.02 REFERENCES

A. Definitions:

- 1. "Manufacturer's installation instructions" includes manufacturer's written instructions; drawings; illustrative, wiring and schematic diagrams; diagrams identifying external connections; and other such information pertaining to installation of equipment and materials. Installation instructions are printed instructions, including those attached to the equipment and materials, all inclusive.
- 2. "Salvage" items are equipment and materials shown on the Contract Documents for selective removal by the Contractor to furnish to the Owner. Contractor shall be responsible for removal, handling, and depositing of equipment and material to location designated by Owner.

B. Reference Standards:

- 1. 29 CFR 1910, OSHA.
- 2. ANSI A10.2, Safety Code for Building Construction

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Review installation procedures under other 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 for connections to existing facilities to prevent delay of the Work.
- 3. Contractor shall remove and dispose of equipment and materials indicated for demolition on the Contract Documents, unless indicated as salvage items for the Owner. Contractor shall obtain ownership of removed equipment and materials following Engineer and Owner approval. Disposal of equipment and materials shall be in accordance with the Contract Documents

B. Sequencing:

1. Coordinate with Owner's Operation and following approval by Engineer and Owner.
2. Contractor shall replace equipment and materials removed without proper authorization from Engineer, which are necessary for the operation of the existing facilities. Re-installation of equipment and materials shall be to the satisfaction of the Engineer at no cost to the Owner

C. Title to Equipment and Materials:

1. Equipment and materials indicated for demolition and removal in the Contract Documents, and not designated as Owner's salvaged items, shall become the Contractor's property following removal from the Site. Contractor shall be responsible for legally disposing of the equipment and material.
2. Contractor shall have no right or title to any of the equipment, materials or other items to be removed until the elements have been removed from the Site.
3. Contractor shall not sell or assign, or attempt to sell or assign any interest in the equipment, materials or other items until removal from Site.
4. Contractor shall have no claim against the Owner because of the absence of equipment, fixtures and materials.

D. Salvage Equipment and Materials:

1. Contract Documents indicate equipment and materials that shall be retained by Owner. Owner has the right to request any demolished equipment and materials be retained at their discretion.
2. Contractor shall move salvaged equipment and materials to storage areas located at the Site as instructed by Owner.
3. Architectural equipment and materials may be salvaged for incorporation into the Work when approved by Engineer.

E. Use of Explosives: Contractor shall not use explosives or blasting equipment and material in the Work in accordance with the Contract Documents.

1.04 SUBMITTALS

A. Action/Informational Submittals:

1. Construction electronic documentation as specified in this Section.

2. Demolition Plan: Submit detailed description of methods, equipment, and sequence for demolition Work.
3. Cutting and Patching Request:
 - a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:
 - 1) Design function or intent of Project.
 - 2) Work of Owner or other contractors.
 - 3) Structural value or integrity of an element of the Project.
 - 4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 5) Efficiency, operational life, maintenance, or safety of operational elements.
 - 6) Visual qualities of sight-exposed elements.
 - b. Request shall include:
 - 1) Identification of Project and contract name and number.
 - 2) Description of affected Work of Contractor and work of others (if any).
 - 3) Necessity for cutting.
 - 4) Effect on work of Owner, other contractors (if any), and on structural or weatherproof integrity of Project.
 - 5) Description of proposed Work, describing: scope of cutting and patching; trades who will be executing the Work; products proposed to be used; extent of refinishing; schedule of operations; alternatives to cutting and patching, if any.
 - 6) Designation of entity responsible for cost of cutting and patching, when applicable.
 - 7) Written permission of other contractors (if any) whose work will be impacted.
4. Recommendation Regarding Cutting and Patching:
 - a. Should conditions of work, or schedule, indicate a change of materials or methods, submit written recommendation to Engineer including:

- 1) Conditions indicating change.
 - 2) Recommendations for alternative materials or methods.
 - 3) Items required with substitution request, in accordance with the substitution request requirements of the Contract Documents and Section 01 61 00 – Product Requirements and Options.
5. Product Data: Submit manufacturer's product data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
 6. Informational Submittal: Submit written indication designating the day and time that the construction associated with cutting and patching will be uncovered, to provide for observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.
 7. Comply with submittal requirements of individual Specification Sections for patching materials.

1.05 SITE CONDITIONS

- A. Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.
- B. Existing Site conditions shall be maintained to the greatest extent possible by the Owner to the time of Notice to Proceed.
- C. Contractor shall perform investigations, explorations and probes as necessary at the Site prior to initiating demolition Work to ascertain any required protective measures before proceeding with demolition and removal. Contractor shall give particular attention to shoring and bracing requirements to prevent damage to the Work and existing structures.
- D. Contractor shall verify measurements, dimensions and other conditions of each existing structure, system, equipment and material indicated in the Contract Documents for new Work prior to ordering equipment and materials.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General:
 1. Provide materials and products in accordance with the individual Specification Sections and the Contract Documents.

2. Provide materials and products that visually match existing adjacent surfaces to fullest extent possible for exposed surfaces.
 3. If not indicated in the Contract Documents, provide materials and products that are identical to existing materials and products affected by the Work.
 4. If identical materials and products are unavailable, provide materials and products that shall equal or exceed performance requirements of existing materials and products.
- B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
1. Product and Manufacturer: Provide one of the following:
 - a. Sikagard 62, by Sika Corporation.
 - b. Or equal.

PART 3 – EXECUTION

3.01 CONSTRUCTION ELECTRONIC DOCUMENTATION

A. Pre-Construction Documentation

1. Contractor shall take photographic and video documentation of the Site where Work is being performed. Engineer and Owner reserve the right to be present during documentation.
2. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site prior to commence Work.
3. Contractor shall submit pre-construction documentation to Engineer and Owner for review. Contractor, Engineer, and Owner shall visit Site to field verify electronic documentation prior to commencing the Work. Site visit verification shall establish existing conditions prior to commencing Work.

B. Construction Progress Documentation

1. Contractor shall document Work progress at locations and construction as directed by Engineer, at a minimum.
2. Contractor shall provide electronic documentation prior to and following any shutdown, switchover, demolition, de-commissioning, cutting, patching, repair, etc. Engineer and Owner reserve the right to be present during documentation.
3. Contractor shall document following exposure of buried utilities, piping, valve, appurtenance and other underground elements.

4. Engineer reserves the right to provide construction progress documentation to confirm Contractor electronic documentation.

C. Post-Construction Documentation

1. Contractor shall take photographic and video documentation of the Site where Work has been completed and prior to Substantial Completion or partial utilization by Owner. Engineer and Owner reserve the right to be present during documentation.
2. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site following completion of the Work.

D. Submittal Requirements:

1. Documentation shall be time stamped for verification, including date and time.
2. Documentation shall be organized in a logic manner, such as by structure, building, physical site location, etc. for easy of comparison.
3. Photographic documentation shall be high resolution electronic versions.
4. Documentation shall be submitted to Engineer for review and approval prior to commence Work and at completion of the Work.

3.02 DEMOLITION

A. General:

1. Demolition Work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as specified in this Section.
2. Contractor shall furnish competent and experienced personnel for the various type of demolition and removal Work. Demolition and removal Work shall be performed with regard to the safety of Owner employees, individuals at the Site, and the public.
3. Contractor shall remove temporary work, such as enclosures, signs, guards, etc. when such temporary Work is no longer required or when directed at the completion of the Work.
4. Contractor shall perform patching, restoration and Work in accordance with individual Specification Sections and details shown on Contract drawings.
5. Contractor shall be responsible for damage caused by demolition Work to existing structures, equipment and materials indicated for reuse or to remain at no additional cost to Owner.

6. Contractor shall maintain a clean working environment during the demolition Work.

B. Protection during Demolition:

1. Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, personnel engaged in demolition Work, and adjacent construction.
2. Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by the Work.
3. Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and Work is being done, connections made, materials handled or equipment moved.
4. Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations in the Contract Documents shall be protected by dust proof partitions and other adequate means.
5. Contractor shall provide adequate fire protection in accordance with Section 01 51 00 – Temporary Utilities and authorities having jurisdiction.
6. Contractor shall perform the demolition Work with minimum traffic interference. Contractor shall not close or obstruct walkways, passageways, or stairways. Contractor shall not store or place materials in passageways, stairs or other means of egress.
7. Contractor shall minimize disturbances to exterior walls and roofs to small sections that are readily repaired and patched to maintain watertight conditions in existing structures and buildings.

C. Performance of Demolition:

1. Equipment, piping, valves and appurtenances:
 - a. Contractor shall drain equipment, piping, valves, and appurtenances prior to demolition Work. Contractor shall be responsible for collection, transport, and disposal of drained contents at no additional cost to the Owner.
 - b. Contractor shall provide line stops, plugs, blind flanges, etc. for equipment, piping, valves and appurtenance required to remain in service during the Project. Contractor shall provide temporary or permanent supports in accordance with the Contract Documents.

- c. Supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise noted in the Contract Documents.
 - d. Concrete bases, anchor bolts and other supports shall be removed to approximately 1 inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas.
 - e. Wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, in accordance with the Contract Documents and as directed by the Engineer.
 - f. Wall sleeves, wall pipes, and wall castings shall be plugged or blanked off in accordance with the Contract Documents and as directed by the Engineer.
 - g. Openings in concrete shall be closed in accordance with the Contract Documents and as directed by the Engineer.
2. Electrical components and equipment:
- a. Contractor shall de-energize panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar electrical equipment prior to removal.
 - b. Contractor shall relocate or isolate electrical equipment and materials that serve equipment, piping, valves and appurtenance that are to remain in service during the Project.
3. Reused and relocated equipment:
- a. Contractor shall receive approval from Engineer prior to removal and relocation of equipment and material. Equipment and materials removed by Contractor prior to Engineer's approval that is required for Owner's operation of the facility shall be reinstalled at no cost to the Owner.
 - b. Prior to removal and relocation Work, equipment and materials indicated for reuse and relocation shall be operated by Owner with Contractor and Engineer present to witness existing functionality and operation.
 - c. Contractor shall provide personnel responsible for reinstallation of equipment and material for the removal Work.
 - d. Contractor shall be responsible and provide storage and protection of equipment and materials in accordance with Section 01 66 00 – Product Storage and Protection Requirements until relocation and reinstallation Work is performed.

- e. Contractor shall provide replacement equipment and material that is damaged during the removal Work at new cost to the Owner. Contractor shall be responsible to provide same type, model, electrical components, etc. equipment and material as approved by Engineer and Owner.
4. Structural removal:
- a. Contractor shall provide and install temporary shoring, struts, and bracing required for the demolition Work for structural materials.
 - b. Contractor shall cut and remove structural material at the interface of demolition Work and the existing structural element. Cutting and removal shall occur in small sections, including masonry units, to prevent instability of structural elements.
 - c. Contractor shall patch, repair, and refinish adjacent surfaces that remain following demolition Work.
 - 1) Adjacent surfaces shall be repaired and refinished to the condition prior to the demolition Work and in accordance with the Contract Documents.
 - 2) Adjacent surfaces shall be cleaned of dirt, grease, loose paint, etc., prior to refinishing.
 - d. Contractor shall limit cutting of existing roof areas designated to remain to the limits required for the proper installation of the Work.
 - 1) Cut and remove insulation, joists, flashing, membranes, shingles, and metals, etc. in accordance with the Contract Documents and as directed by the Engineer for installation of the Work.
 - 2) Provide temporary weather tight protection as required until new roofing and flashings are installed.
5. Architectural repairs and removal Work, not specifically shown on the Drawings, may include, but not limited to, the following:
- a. Brickwork: Re-pointing; removing and replacing broken, cracked, disintegrating and missing materials.
 - b. Windows: Removing cracked or disintegrating sealant material; replacing missing or broken glass; re-caulking and sealing frames; glazing sealants.
 - c. Re-finishing: Removing rust, sealing or peeling paint from surfaces by scraping, sanding or wire brushing; priming and repainting surfaces.

- d. Roofing: Patching and repairing membrane or built-up roofing; metal flashing repair; correcting roof pitch to eliminate ponding; cleaning and/or replacing roof drains.
- e. Masonry: Cutting and installing new expansion and control joints.
- f. Parapets: Removing and construction of new walls and copings; clean and patching of copings; replacing copings where broken.
- g. Concrete surfaces: Patching, cleaning, sealing and resurfacing floors, walls, lintels, sills and trim. Replace lintels where broken. Patching or replacing broken, spalled, cracked and disintegrating concrete encased steel columns and piers.
- h. Openings: Cutting and modifying as required for new Work. Provide new lintels, doors and frames.
- i. Doors: Patching and refinishing doors and frames.
- j. Ceilings: Patching, refinishing and replacing.
- k. Guards, handrails and appurtenances: Cleaning and repainting steel materials. Replacing steel material with new aluminum material.
- l. Demolished Exterior Openings: Remove window sash, frame, sill, stool and trim at exterior doors indicated for enclosure and sealing. Provide brick and/or masonry block for closure and sealing.

D. Maintenance during Demolition:

- 1. Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, generated by the demolition Work.
- 2. Contractor shall provide cleaning and waste management of demolition equipment and materials.

3.03 CUTTING AND CORING

A. General:

- 1. Contractor shall notify Engineer in writing and receiving Engineer's approval prior to cutting load bearing walls (concrete or masonry) and structural concrete floors.
- 2. Perform cutting and coring to limit extent of patching required.
- 3. Structural Elements: Do not cut or core structural elements in manner that would change structural element's load-carrying capacity as load deflection ratio.

4. Operating Elements: Do not cut or core operating elements in manner that would reduce capacity to perform as intended. Do not cut or core operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.
5. Replace, patch, and repair materials and surfaces cut or damaged during cutting and coring Work, Contractor shall use methods that do not void required or existing warranties.
6. Provide temporary or permanent bypass provisions prior to cutting existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated in accordance with the Contract Documents.
7. Inspection: Examine and prepare surfaces prior to commencing Work. Contractor shall report unsatisfactory or questionable conditions to Engineer in writing. Contractor shall not proceed with the Work until unsatisfactory conditions are corrected.
8. Preparation:
 - a. Provide temporary support required to maintain structural integrity, to protect adjacent Work from damage, and to support the element(s) to be cut or cored.
 - b. Protection of Existing Construction During Cutting and Coring:
 - 1) Protect existing structures, equipment, and materials during cutting and coring to prevent damage.
 - 2) Provide protection from adverse weather conditions that will be exposed during cutting and coring Work.
 - 3) Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
9. Restoration:
 - a. Clean equipment, materials, piping systems, valves, conduit and appurtenances that were damaged due to the Work prior to applying paint or other finishing materials.
 - b. Restore damaged pipe coverings, including insulation, to original condition.

B. Cutting:

1. General:

- a. Cut existing structures and appurtenances that provide surfaces for installation or repair of the Work. Cut existing construction using methods to minimize damage and disturbance to retained and adjoining construction elements.
 - b. Cutting equipment used shall be hand or small power tools suitable for sawing or grinding. Avoid using hammering or chopping equipment for cutting Work.
 - c. Cut holes and slots as small as possible and to size required for incorporation of the Work and in accordance with the Contract Documents.
 - d. Cut or drill from exposed or finished side to concealed side to avoid marring finished surfaces.
 - e. Provide adequate bracing of area to be cut prior to cutting.
 - f. Provide equipment and material to remove cut spoils.
 - g. Provide temporary protection for cut openings where and when Work is not being performed.
2. Concrete and Masonry:
- a. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
 - b. Provide control for slurry generated during sawing on both sides of element being cut.
 - c. After cutting concrete and before installing new Work on or through the opening, coat exposed concrete and steel with protective coating material specified in this Section. Apply protective coating in accordance with manufacturer's instructions.

C. Coring:

1. Core-drill holes through concrete and masonry walls, slabs, or arches, in accordance with the Contract Documents, unless written authorization is furnished by Engineer.
2. Protection: Protect existing structures, equipment, materials, utilities, and adjacent areas from water and other damage by core-drilling Work.
3. Coring:
 - a. Perform coring with non-impact rotary tool using diamond core-drills.

- b. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration and in accordance with the Contract Documents.
 - c. After core-drilling and before installing equipment and material through the penetration, coat exposed concrete and steel with protective coating material specified in this Section. Apply protective coating in accordance with manufacturer's instructions.
4. Cleaning: Vacuum or otherwise remove slurry and tailings from the work area following core-drilling.

3.04 PATCHING

A. General:

1. Construction shall be patched by filling, repairing, refinishing, closing-up, and similar methods at completion of the Work.
2. Provide equipment and materials in accordance with the Contract Documents for patching Work. Comply with manufacturer's installation instructions.
3. Provide airtight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces when patching the Work. Provide durable patching seams that minimize visual appearance.
4. Patched areas shall be tested to demonstrate integrity of installation as directed by the Engineer. Contractor shall provide testing equipment, material and services for patch testing.

B. Restoration:

1. Restore exposed finishes of patched areas to minimize evidence of patching and refinishing.
2. Contractor shall extend refinishing and restoration into adjoining areas to blend patched areas with existing adjacent areas.
 - a. Refinish to nearest intersection for continuous surfaces.
 - b. Refinish the entire assembly and system for equipment and materials.
 - c. Repair and rehang existing ceilings to provide an even-plane surface of uniform appearance.
 - d. Apply plaster and finishes to match adjacent interior walls and partition areas for openings sealed with brick and/or masonry block.

3.05 INSTALLATION

- A. Install equipment and materials in accordance with the Contract Documents, approved Shop Drawings, and manufacturer's installation instructions. When manufacturer's installation instructions conflict with the Contract Documents, obtain interpretation or clarification from Engineer before proceeding.
- B. Preparation of surfaces shall be performed prior to installation of equipment and material.
 - 1. New floor finishes: Repair and patch with concrete, asphalt latex type emulsion and underlayment as required for existing surfaces or new flooring surface.
 - 2. Ceramic tile flooring or bases installed over concrete floors: Grind away cove, if present, for installation of new Work.
- C. Concrete surfaces shall achieve compression strength in accordance with the Contract Documents prior to installation of equipment and materials.
 - 1. Anchor bolts and templates shall be provided by Contractor and as specified in the individual Specification Sections.
 - 2. Concrete foundations shall be treated with sealer to prevent oil from seeping into concrete as specified in the individual Specification Sections.
- D. Maintain the work area in a broom-clean condition while installing materials and equipment.
- E. Contractor shall be responsible for equipment for hoisting, lifting, moving, rigging, etc. for installation of equipment and materials.
 - 1. Contractor shall be responsible for design of temporary installation system used for the installation Work, unless otherwise indicated in the Contract Documents.
 - 2. Contractor shall be responsible for damage to existing structure, equipment, and material caused prior, during, and following installation of the Work with the Contractor furnished temporary installation system at no cost to Owner. Repairs shall be in accordance with the Contract Documents, shall return to condition prior to installation Work, and as directed by the Engineer.
 - 3. Owner's hoists, monorails, bridge cranes, rigging, etc. shall not be used by the Contractor unless written authorization is provided by Owner.
- F. Alteration or repair of new equipment and materials shall not be permitted without written authorization from Engineer.

- G. Field welding or burning of new equipment and materials shall not be permitted unless indicated in the Contract Documents or without written authorization from Engineer.
- H. Contractors shall install temporary shoring and bracing where necessary during installation of the Work where required:
 - 1. System shall be provided in accordance with the Contract Documents and code requirements.
 - 2. Temporary system shall consist of adjustable sound timbers or rolled shapes easily removable following installation of the Work.
 - 3. Contractor shall be responsible for damage to existing structures and new Work during installation, utilization, and removal of the temporary system at new additional cost to the Owner.
- I. Manufacturer's Installation Services: Provide competent, qualified manufacturer's representatives of equipment and material for services specified in the individual Specification Sections, including, but not limited to:
 - 1. Supervising installation
 - 2. Checking the completed installation
 - 3. Adjusting and testing of equipment and materials
 - 4. Instructing Owner's operations and maintenance.

END OF SECTION

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 G's. Displacement and velocity shall be measured by suitable equipment equal to IRD Mechanalysis, Bentley, Nevada.
- B. Coordination:
 - 1. Coordinate checkout and start-up with other contractors, as necessary.

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. Owner will provide sufficient personnel to assist Contractor in starting up equipment, but responsibility for proper operation is by Contractor.
 4. Supplier shall be present during checkout, start-up, and initial operation, unless otherwise acceptable to Engineer.
 5. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by Contractor.
- 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.
 - b. Provide training of operations and maintenance personnel.
 - c. 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.
 - 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.

- d. 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. (Not Used)
- C. Closeout Submittals: Manufacturer's certification of installation in accordance with this Section.

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 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 satisfactory mechanical operation of the plant facilities.

3.02 FIELD QUALITY CONTROL

- A. Manufacturers' Field Services:
 - 1. When specified, furnish services of competent, qualified 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 (NOT USED)

3.04 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, 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 such as 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

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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. (Not Used)
 - b. Electronic Copies: One copy.

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- 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.
 - 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 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. Also submit drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", ".gif", ".dwt", or ".dwg". Submit files in a separate directory on the CD.

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.

END OF SECTION

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. Submit electronic files on compact disc labeled, “Supplemental Record Drawings”, together with Contractor name, Project name, and Contract name and number.

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 02 41 00
DEMOLITION

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, and equipment in accordance with the requirements of
 - 1. Section 01 14 00 – Coordination with Owner’s Operations
 - 2. Section 01 73 00 – Execution of Work
- B. In addition, the Contractor shall demolish and remove all concrete and asphalt paving, curbs, sidewalk, and miscellaneous yard piping, utilities, and structures as required and shown on the Contract Drawings during the construction work.

PART 2 – EXECUTION

2.01 DEMOLITION

- A. Existing concrete and asphalt paving, curbs, sidewalk and miscellaneous yard piping, utilities, and structures within the areas designated for new construction work shall be completely demolished and all debris removed from the site.
- B. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris.
- C. Work shall be performed in such manner as not to endanger the safety of the workmen or the public or cause damage to nearby structures.
- D. Provide all barriers and precautionary measures in accordance with Owner's requirements and other authorities having jurisdiction.
- E. Where parts of existing pavements or structures are to remain in service, demolish the portions to be removed, repair damage, and leave the pavement or structure in proper condition for the intended use. Remove asphalt or concrete pavement, concrete, and masonry to the lines designated by saw-cutting, drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.

- F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby pavements and 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. Contractor shall provide Owner a copy of all records of the joint survey of conditions before demolition activities may begin. Contractor shall provide copies of the existing conditions survey report to the Owner and Engineer before any demolition or construction activities begin.

2.02 DISPOSAL OF MATERIAL

- A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor at a properly permitted facility 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. All other material shall be disposed of off-site by the Contractor at his expense.
- B. Burning of any debris resulting from the demolition will not be permitted at the site.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

**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 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 SP66 - 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 Billet-Steel Bars for Concrete Reinforcing
 - 8. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

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 - (SP66), 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. Mill test certificates - 3 copies of each.
3. Description of the reinforcing steel manufacturer's marking pattern.
4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.
5. Proposed supports for each type of reinforcing.
6. Request to use splices not shown on the Drawings.

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.

PART 2 – PRODUCTS

2.01 REINFORCING STEEL

- A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. 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.
- 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. Field welding of reinforcing steel will not be allowed.
- E. 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.

PART 3 – EXECUTION

3.01 TEMPERATURE REINFORCING

- A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 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 rebent 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.

3.03 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 be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.
- C. Reinforcing steel shall at all times 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 there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 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 in order 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 rebent 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.

3.05 SPLICING

- A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is 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.
- E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely 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.

3.06 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

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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 following types of concrete:
 - 1. Class A2 Concrete: Normal weight structural concrete.
 - 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 21 00 – Reinforcing Steel
- B. Section 03 35 00 – Concrete Finishes
- C. Section 03 39 00 – Concrete Curing
- D. 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. North Carolina 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 305.1 – Specification for Hot Weather Concreting
 - 6. ACI 306.1 – Standard Specification for Cold Weather Concreting

7. ACI 309 – 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 172 – Standard Practice for Sampling Freshly Mixed Concrete
22. ASTM C 192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24. ASTM C 260 – Standard Specification for Air-Entraining Admixtures for Concrete
25. ASTM C 295 – Standard Guide for Petrographic Examination of Aggregates for Concrete

26. ASTM C 457 – Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete
27. ASTM C 494 – Standard Specification for Chemical Admixtures for Concrete
28. ASTM C 595 – Standard Specification for Blended Hydraulic Cements
29. ASTM C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
30. ASTM C 989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
31. ASTM C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
32. ASTM C 1260 – Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
33. ASTM C 1567 – Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
34. ASTM C 1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
35. 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 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.
 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. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

1.05 QUALITY ASSURANCE

- A. Field quality control tests 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.

1.06 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 2.02 or 2.03 respectively.
 2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:
 - a. For concrete mixed with only Portland Cement, the total alkalis in the cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.40%.
 - b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalis in the Portland Cement (calculated as the percentage of Na_2O plus 0.658 times the percentage of K_2O) shall not exceed 0.85%.
 3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalis in the cement shall not exceed 1.0%.
 4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

1.07 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.

- 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 2.05 are used in the concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- 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.

1.08 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 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag cement. The percentage of slag cement shall be set to meet the mean mortar bar expansion requirements in provisions of Article 2.05.G.2.
- 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.

1.09 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.

1.10 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 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 similar to 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 C-1778 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%.
- H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

1.11 ADMIXTURES

- A. Admixtures containing intentionally added chlorides shall not be used.
- B. 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.
- C. 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 BASF Corporation, 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 BASF Corporation, and "Daracem 100 or Advaflo 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 BASF Corporation, "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 BASF Corporation, 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 BASF Corporation, or equal.
- D. 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.
- E. 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.

1.12 CONCRETE MIX DESIGN

- A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used, they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or 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 refers to the total combined weight of all cement, fly ash, and slag cement contained in the mix.
 1. Compressive Strength (28-Day)

Concrete Class A2	4,000 psi (minimum)
Concrete Class B	3,000 psi (minimum)

2. Water/cementitious materials ratio, by weight

	Maximum	Minimum
Concrete Class A2	0.45	0.39
Concrete Class B	0.50	0.39

3. Slump range

- a. 4" nominal unless high range water reducing admixture is used
- b. 8" max if high range water reducing admixture is used.

4. Air Content

Concrete Class A2	6% ±1.5%
Concrete Class B	3% Max (non air-entrained)

PART 2 – EXECUTION

2.01 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 3.03 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. 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.
2. 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
3. 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.
4. 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.

5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

2.02 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 practicable 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 3.09 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 a sufficient number of 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 the area of 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 feathered edges, 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.

2.03 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.

2.04 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 a minimum number of 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.

2.05 ORDER OF PLACING CONCRETE

- A. In order 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.

2.06 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 in excess of 100°F. in order 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.

2.07 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 his 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.

2.08 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 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 in excess of 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 himself 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. Such box shall be equipped to provide the moisture 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 such 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 2.08).
 - 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. 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.
5. 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.
 - a. 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.
2. 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 Specification C 457.

2.09 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.

END OF SECTION

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SECTION 03 35 00
CONCRETE FINISHES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all 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 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. ACI 301 – Specifications for Structural Concrete for Buildings
 - 2. ACI 318 – Building Code Requirements for Structural Concrete

PART 2 – EXECUTION

2.01 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 "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.

2.02 FINISHES ON EQUIPMENT PADS

- A. 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.

2.03 CONCRETE FINISH SCHEDULE

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 of time 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 30 00 – Cast-In-Place Concrete
- B. 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 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, and Cure & Seal 30 Plus by Symons Corporation.
- 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 BASF Corporation, "MasterKure ER 50", or Euclid Chemical "Euco-Bar".

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, provision shall be made for maintaining the concrete in a moist condition for at least a 5-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, 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 five days. Use of a curing compound will not be acceptable for applications of this type.
- 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 ground granulated blast furnace slag. 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 sun shades 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 never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. 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 period, and the subsequent appearance of the concrete surface shall not be affected.
- C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

- A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:
1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.
 2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

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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 03 21 00 – Reinforcing Steel
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. Section 03 35 00 – Concrete Finishes
- D. Section 03 39 00 – Concrete Curing
- E. Section 03 60 00 – Grout
- F. Section 05 05 13 – Galvanizing
- G. Section 05 05 23 – Metal Fastening
- H. Section 05 10 00 – Metal Materials

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 end of the Bid.
 - 1. North Carolina Building Code
 - 2. ACI 318 – Building Code Requirements for Structural Concrete
 - 3. ASTM D2240 – Standard Test for Rubber Property – Durometer Hardness
 - 4. PCI Standard MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
 - 5. PCI Design Handbook

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 concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.
 - 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, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer 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 only 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.

PART 2 – PRODUCTS

2.01 CONCRETE

- A. Concrete materials including Portland cement, aggregates, water, and admixtures shall conform to Section 03 30 00 – Cast-in-Place Concrete.

- 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.

2.02 GROUT

- A. Grout for joints between panels 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.

2.03 REINFORCING STEEL

- A. Reinforcing steel used for precast concrete construction shall conform to Section 03 21 00 – Reinforcing Steel.

2.04 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 in accordance with Section 05 05 13 – Galvanizing.

2.05 WELDING

- A. Welding shall conform to Section 05 05 23 – Metal Fastening.

2.06 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 with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.
- B. All cover of reinforcing shall be the same as detailed on the Drawings.
- C. 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.
- D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.
- E. 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.
- F. 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.
- G. 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, 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.

3.03 ERECTION

- A. Erection shall be carried out by the manufacturer or under his 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 his 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 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)

1.03 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.

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.
4. Sand shall conform to the requirements of ASTM C33.

B. Non-Shrink Grout

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, "Euco N-S" by the Euclid Chemical Company, "SikagROUT 212" by Sika Corporation, "Conspec 100 Non-Shrink Non-Metallic Grout" by Conspec, "MasterFlow 928" by BASF Corporation.

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.
 - 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 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 particular 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 poured from one side only and thence flow across to the open side to avoid air-entrapment.

END OF SECTION

SECTION 05 05 13
GALVANIZING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

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. North Carolina Building Code
2. ASTM A123 – Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A653 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
5. ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
6. ASTM A780 – Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings
7. ASTM F2329 – Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

PART 2 – PRODUCTS

2.01 GALVANIC COATING

- A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 – EXECUTION

3.01 FABRICATED PRODUCTS

- A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.
- B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.
- C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.02 HARDWARE

- A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153 and ASTM F2329.

3.03 ASSEMBLED PRODUCTS

- A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.
- B. Assemblies shall be provided with vent and drain holes as required by the fabricator. Vent and drain hole sizes and locations shall be included in the structural steel shop

drawings required in Section 05 12 00 – Structural Steel for approval. All vent and drain holes shall be plugged and finished to be flush with and blend in with the surrounding surface. Where water intrusion can occur, the plug shall be carefully melted into the surrounding zinc coating using an appropriate fluxing agent.

3.04 METAL DECK

- A. Unless noted otherwise, metal deck shall be galvanized in accordance with ASTM A653 G60 minimum. In moist environments or as indicated on the Contract Drawings, galvanizing shall meet the requirements of ASTM A653 G90.
- B. Galvanized metal deck shall meet the requirements of ASTM A924.

3.05 REPAIR OF GALVANIZING

- A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

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
- C. Section 05 12 00 – Structural Steel

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. North Carolina 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. ASTM A572/A572M-94C – Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
13. ASTM A36 – Standard Specification for Carbon Structural Steel
14. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts
15. ASTM F436 – Standard Specification for Hardened Steel Washers
16. ASTM F593 – Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
17. ASTM F594 – Standard Specification for Stainless Steel Nuts
18. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
19. 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. A current Evaluation Report shall be submitted for all anchors that will be considered for use on this project.
 4. Manufacturer's installation instructions.
 5. Copy of valid certification for each person who is to perform field welding.
 6. Certified weld inspection reports, when required.
 7. Welding procedures.
 8. Installer qualifications.
 9. Certification of Installer Training.

- 10. Inspection Reports.
- 11. Results of Anchor Proof Testing.

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 (for mechanical anchors) or 355.4 (for 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 installer 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.

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. 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. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.
- C. 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-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593 Grade A325 or F1852. 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.

- 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 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; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:
 - a. Mechanical anchors include any of the following anchors:
 - i. 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.
 - ii. 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 or bolts 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. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.
3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.
4. 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.
5. 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 anchor non-structural elements.

6. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Concrete Anchor Design:

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, it shall be considered an engineered design and 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 anchors will be considered an engineered design and 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 by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

- a. The Contractor shall submit an engineered design with signed and sealed calculations 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 Chapter 17.
- b. Embedment Depth
 - a. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design.
 - b. Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or 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).
 - c. 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.

C. Anchors:

1. Mechanical Anchors:

- a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "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” and “KWIK HUS-EZ-I” by Hilti, Inc., “Titen HD” by Simpson Strong-Tie Co., or “Screw-Bolt+” by DeWalt. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.
 - 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, “HSC-A” by Hilti, Inc. or approved equal.
 - e. 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 “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “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 AC308, 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.**

D. Concrete Anchor Materials:

- 1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system, 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 Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.
- 3. Nuts, 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 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 ANCHOR INSTALLATION

- A. Anchor Rods, Concrete Anchors, and Masonry Anchors
 - 1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, 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. Concrete anchors shall not be used in place of 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. 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 shall be at least 50 degrees F.
2. 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.
3. 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 by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. 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.
4. All adhesive anchor installations in the horizontal to vertically overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-14 17.8.2.2. Current AAI Certificate must be submitted to the Engineer of Record prior to commencement of any adhesive anchor installations.

D. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
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.

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 structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

END OF SECTION

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 36
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
Structural Shapes	ASTM A276
Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

- A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

Structural Shapes	ASTM B308
Castings	ASTM B26, B85, or B108
Extruded Bars	ASTM B221 - Alloy 6061
Extruded Rods, Shapes and Tubes	ASTM B221 - Alloy 6063
Plates	ASTM B209 - Alloy 6061
Sheets	ASTM B221 - Alloy 3003

C. All aluminum shall be provided with mill finish unless otherwise noted.

D. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

Gray	ASTM A48 Class 30B
Malleable	ASTM A47
Ductile	ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

Rods, Bars and Sheets	ASTM B138 - Alloy B Soft
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2.06 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			•	•	•	•	•	•	•

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
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

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SECTION 05 12 00
STRUCTURAL STEEL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 13 – Galvanizing
- C. Section 05 05 23 – Metal Fastening

1.03 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. North Carolina Building Code
 - 2. AISC – "Code of Standard Practice"
 - 3. AISC – "Specification for Structural Steel Buildings"
 - 4. AISC – RCSC "Specification for Structural Joints Using High Strength Bolts"
 - 5. AWS – "Structural Welding Code"
 - 6. ASTM A786 – Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Certified Mill Test Reports
 - 2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:
 - a. Layout drawings indicating all structural shapes, sizes, and dimensions.
 - b. Beam and column schedules.
 - c. Detailed drawings indicating jointing, anchoring and connection details and vent and drain holes where required.

1.05 QUALITY ASSURANCE

- A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.
- B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.
- C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Structural Steel
 1. Structural steel for W, C, and MC shapes shall conform to ASTM A992 unless otherwise indicated.
 2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.
 3. Structural steel for S and M shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.
 4. Steel pipe shall be ASTM A53, Grade B.

5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.
 6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.
 7. Fasteners for structural steel shall be in accordance with Section 05 05 23 – Metal Fastening.
- B. Welds
1. Electrodes for welding shall be in accordance with Section 05 05 23 – Metal Fastening.

PART 3 – EXECUTION

3.01 MEASUREMENT

- A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

- A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.
- B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.
- C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods, vent and drain holes or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.
- D. All materials shall be properly worked and match-marked for field assembly.
- E. Where galvanizing of structural steel is required, galvanizing shall be done in accordance with Section 05 05 13 – Galvanizing..

3.03 DELIVERY, STORAGE AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

- A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.
- B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.
- C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.
- D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.
- E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05 05 23 – Metal Fastening.
- F. All bolted connections shall use high strength bolts in accordance with Section 05 05 23 – Metal Fastening. High strength bolts shall be installed in accordance with RCSC "Specification for Structural Joints Using High Strength Bolts". Bolts specified or noted on the Drawings to be a tension or slip critical "SC" type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.
- G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.
- H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.
 2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.
 3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.
- I. Grouting of Base Plates and Bearing Plates
1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.
 2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.
 3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03 60 00 – Grout.
 4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.
- J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

- A. Painting shall be performed according to Section 09 90 00 – Painting and the following additional requirements.
1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.
 2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

END OF SECTION

SECTION 05 31 00
METAL DECKING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, equipment, materials and services to install all metal deck complete with all accessories for a complete installation in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05 10 00 – Metal Materials
- B. Section 05 05 13 – Galvanizing
- C. Section 05 05 23 – Metal Fastening
- D. Section 05 12 00 – Structural Steel

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. AISI – Specification for the Design of Cold-Formed Steel Structural Members
- B. SDI – Design Manual for Floor Decks and Roof Decks and Manual of Construction with Steel Deck
- C. ASTM Standards for Test Methods
- D. AWS D1.3 – Structural Welding Code – Sheet Steel
- E. ANSI/SDI RD-2010 – Standard for Steel Roof Deck
- F. ANSI/SDI NC1.0-2006 – Standard for Non-Composite Steel Floor Deck

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Complete layout and installation drawings and schedules with clearly marked dimensions.
 - 2. Detail and location drawings for all framing, supports, type and location of all welds and fasteners.
 - 3. Details of all accessories showing welding washers, studs and reinforcing strips.

4. Manufacturer's design calculations or published literature for the structural properties of the metal decking.
5. Qualifications of welders.

1.05 QUALITY ASSURANCE

- A. All materials, workmanship and production methods shall be in accordance with ANSI/SDI RD-2010 for Roof Deck and ANSI/SDI NC1.0-2006 for Non-Composite Floor Deck.
- B. Manufacturer shall be regularly engaged in the manufacture of metal decking.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Steel sheet shall be flat rolled carbon steel sheets meeting the requirements of ASTM A653 Grade 80 for galvanized metal deck or ASTM A1008 Grades 80 for bare metal deck.
- B. Minimum yield strength shall be 33 ksi.
- C. Unless noted otherwise, metal deck shall be galvanized in accordance with Section 05 05 13 – Galvanizing.
- D. Mechanical fasteners used for sidelap connections shall be SDI standard.

PART 3 – EXECUTION

3.01 FABRICATION AND DESIGN

- A. Design, fabrication and erection of decking shall comply with references listed in Section 1.03 and manufacturer's recommendations.
- B. Deck units shall conform to the SDI standard type and gage shown on the Drawings.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in unbroken, undamaged, original packages bearing manufacturer's labels.
- B. Metal decking shall be stored off the ground with one end elevated for drainage and covered with vented water-proof material in accordance with decking manufacturer's recommendations.

- C. Decking shall be handled so as to preclude damage from any source.
- D. Metal decking units may not be used for any purpose (such as scaffold decking) prior to incorporation in the work. Any units which have been so used will be rejected.

3.03 INSPECTION

- A. Verify correct layout and alignment of supporting members and clean all support surfaces of debris. All defects shall be corrected prior to installation of metal decking.

3.04 INSTALLATION

- A. Install deck units and accessories in accordance with shop drawings and manufacturer's recommendations. Deck units shall be installed where called for on the Drawings.
- B. Position deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened. Extend deck units over three or more supports unless shown otherwise on the Drawings. Lap ends not less than 2 inches. Place deck units flat and square, secured to adjacent framing without warp or deflection.
- C. Secure deck units to supporting members as shown on the Drawings. Weld pattern shall be as indicated on the Drawings in accordance with SDI and AWS D1.3. The Contractor may use an equivalent pattern of mechanical fasteners in lieu of welded fastening.
- D. Attach deck at sidelaps with screws as indicated on the Drawings or as recommended by the manufacturer.
- E. Cut and fit deck units around openings. Deck manufacturer shall approve openings larger than 6" diameter prior to cutting.

3.05 REPAIR OF GALVANIZING

- A. Galvanizing shall be repaired at all welds, scarred areas, and rust spots in accordance with Section 05 05 13 – Galvanizing.

3.06 CONSTRUCTION GUIDELINES

- A. Do not use deck units as a working platform or storage area until units are permanently attached in position.
- B. Construction loads shall not exceed the load carrying capacity of the deck.

C. All units damaged during construction shall be repaired or replaced by the Contractor.

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.

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. North Carolina 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 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 13 – Galvanizing
- C. 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. North Carolina 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 GRATING

- A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.
 1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.
 2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.
 3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 100 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.
 4. Grating installed in cast-in-place concrete shall be provided with embedded support frames on all perimeter and bearing edges. Support frames shall be

extruded frames with continuous means of anchoring frames to concrete around entire perimeter of frame. Support frames shall be fabricated from the same material as the grating.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating attachment to frames and any other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Grating shall be "19-SI-4 I-Bar Swage Locked" by Alabama Metal Industries Corporation (AMICO), "IB" by Harsco Industrial IKG, "I-Bar 19SGI4", by Ohio Grating Inc., or "I-Bar" by Thompson Fabricating LLC.

C. Aluminum Plank Grating

1. Aluminum plank grating shall be unpunched planks of extruded aluminum welded together to form panels. Panel ends shall have an extruded aluminum end bar welded in place. Two stainless steel recessed lifting handles shall be provided for individual panels, one handle at each end, where specifically shown on drawings. All support members shall be aluminum. Plank clips for grating attachment to frames and any other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.
2. Aluminum plank grating shall be HD-P manufactured by Harsco Industrial IKG., Heavy Duty Series manufactured by Ohio Gratings, Inc., or Unpunched Duo-Grip Extruded Series manufactured by Alabama Metal Industries Corporation (AMICO).

D. Heavy Duty Steel Grating

1. Heavy duty steel grating shall be galvanized according to Section 05 05 13 – Galvanizing.
2. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating. Provide embedded galvanized steel support frames for cast-in-place concrete installations.
3. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for H-20 truck.
4. Grating shall be manufactured by Harsco Industrial IKG, Alabama Metal Industries Corporation (AMICO), and Ohio Gratings, Inc.

2.04 CHECKERED FLOOR PLATES

- A. Floor plates shall meet the requirements of ASTM C1802 for Load Level 1 – Light Pedestrian Load, minimum, unless otherwise indicated on the Drawings.
- B. Floor plates shall be aluminum unless noted otherwise.
- C. All floor plates shall be checkered plate with an approved raised pattern, non-skid surface.
- D. Openings greater than 42 inches in either direction shall require two plates opening via hinges in opposite directions.
- E. Floor plates shall be designed to carry a minimum service level live load of 150 psf, or a concentrated load of 300 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 greatest stresses, both due to maximum moment and maximum shear load conditions.
- F. All components of checkered floor plates 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.
- G. Live load deflection shall be limited to $L/200$ of the span, but no greater than $3/16$ inch.
- H. All checkered floor plates shall be fabricated from $1/4$ " plate, minimum and shall be stiffened as required to maintain allowable stress and deflection requirements specified herein.
- I. Stiffeners shall consist of angles or bars welded to the bottom of the plate.
- J. Checkered floor plate hinges shall be either stainless steel or aluminum with stainless steel pins and fasteners.
- K. All checkered floor plates shall be provided with recessed handles. Handle material shall be as shown on the Contract Drawings.
- L. Air-tight and water-tight checkered floor plates shall be provided with a $1/8$ -inch-thick neoprene gasket between the checkered plate and the support frame. Gasket material shall be bonded to the support frame and checkered floor plates shall be bolted to the structural support frame with countersunk stainless-steel flathead screws.
- M. All floor plates shall be clearly marked with the information listed below. Markings shall be indicated on metal or plastic tags permanently attached to the floor plate or frame or shall be permanently painted or printed.
 - 1. The manufacturer's name or trademark, location, and telephone contact number.

2. The manufacturer's model number and ASTM designation.
3. 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.
4. Date of manufacture and/or serial number.

2.05 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 clear opening dimensions.
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.
5. Doors required to support traffic loadings shall meet the requirements of ASTM C1802 for Load Level 4 – Occasional Truck Traffic, unless otherwise indicated on the Drawings.
- a. For openings less than or equal to 48 inches, the design loading shall consist of a service level 16,000 pound load applied over a 10 inch by 20 inch area with traffic both parallel and perpendicular to the span considered. Loadings shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.
 - b. For openings greater than 48 inches, two load cases shall be considered. Load Case 1 shall consist of two service level 16,000 pound loads spaced at 48 inches on center with each load applied over a 10 inch by 20 inch area and assuming the traffic direction is perpendicular to the span of the door. Load Case 2 shall consist of two service level 12,500 pound loads spaced at 48 inches on center with each load applied over a 10 inch by 20 inch area and assuming the traffic direction is parallel to the span of the door. Loadings for both cases shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.
 - c. Live load deflections shall be limited to $L/250$ of the span, but not greater than $3/16$ inch, and shall be determined based off a service level 16,000 pound load.
 - d. Unless otherwise noted, doors rated for H-20 traffic loading shall have an integral gutter system and be Type "FDDH" by Nystrom, Type "H1C" or "H2C" by Halliday Products, Inc., Type "THS" or "THD" by U.S.F. Fabrication Inc., Type "THG-H20" by Thompson Fabricating LLC, or "Type JAL-H20" or "JDAL-H20" by the Bilco Company..

C. Roof Access Doors

- 1. Doors shall be designed for 50 psf live load unless noted otherwise.
- 2. Doors for service stairs shall be Bilco Type L roof Scuttles.
- 3. Doors for ladder access shall be Bilco Type S or SS Roof Scuttles.

D. Fixed Ladders

1. Where the Contract Documents indicate fixed ladders are required under access doors, 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. The safety posts shall be manufactured of 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 posts shall be assembled in strict accordance with manufacturer's recommendations.

2.06 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 where 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.

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SECTION 05 56 00
CASTINGS

PART 1 – GENERAL

1.01 REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 33 05 61 – Utility Structures
- B. Section 05 10 00 – Metal Materials

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. North Carolina Building Code

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
 - 1. Complete fabrication and erection drawings of all castings 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 for castings shall conform to Section 05 10 00 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

- A. All welds and fasteners used for castings shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

2.03 IRON CASTINGS

- A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets/.
 - 1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.
 - 2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.
 - 3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.
- B. Covers and Grates
 - 1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.
 - 2. Round covers and frames shall have machined bearing surfaces.
 - 3. Design loadings:
 - a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.
 - b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.
- C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

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. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

3.02 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

END OF SECTION

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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 (NOT USED)

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 50% 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 BASF Construction Chemicals.
3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by BASF Construction Chemicals.
4. (Not Used)
5. (Not Used)
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 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, Sonolastic Ultra by BASF Construction Chemicals.

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
¼ 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.
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. ⁴	Type 1	Manufacturer's standard
Submerged in liquids with high concentration of chlorine (> 2 ppm) or wastewater.	Type 7	Manufacturer's standard
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.

END OF SECTION

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SECTION 09 90 00
PAINTING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein. Tanks are to be coated with the systems listed in tables 1 and 2.

- B. Section Includes:
 - 1. Paint Materials
 - 2. Shop Painting
 - 3. Field Painting
 - a. Surface Preparation
 - b. Piping and Equipment Identification
 - c. Schedule of Colors
 - d. Work in Confined Spaces
 - e. OSHA Safety Colors

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
 - 1. SSPC – The Society for Protective Coatings Standards
 - a. SSPC-Vis 1 – Pictorial Surface Preparation Standards for Painting Steel Structures
 - b. SSPC-SP2 – Hand Tool Cleaning
 - c. SSPC-SP3 – Power Tool Cleaning
 - d. SSPC-SP5/NACE 1 – White Metal Blast Cleaning
 - e. SSPC-SP6/NACE 3 – Commercial Blast Cleaning

- f. SSPC-SP7/NACE 4 – Brush-off Blast Cleaning
 - g. SSPC-SP10/NACE 2 – Near-White Metal Blast
 - h. SSPC-SP11 – Power Tool Cleaning to Bare Metal
 - i. SSPC-SP13/NACE6 – Surface Preparation of Concrete
- 2. ICRI – International Concrete Repair Institute
 - 3. NACE – National Association of Corrosion Engineers
 - 4. NAFP – The National Association of Pipe Fabricators
 - 5. ASTM D1737 – Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
 - 6. ASTM B117 – Method of Salt Spray (Fog) Testing
 - 7. ASTM D4060 – Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser
 - 8. ASTM D3359 – Method for Measuring Adhesion by Tape Test

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01 33 00 – Submittal Procedures, submit the following:
 - 1. Manufacturer's literature and Material Safety Data Sheets for each product.
 - 2. Painting schedule identifying surface preparation and paint systems proposed. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.04 SYSTEM DESCRIPTION

- A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenances.

- B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.
- C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.
- D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.05 QUALITY ASSURANCE

- A. Painting operations shall be accomplished by skilled craftsman and licensed by the state/commonwealth to perform painting work.
- B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.06 STORAGE AND DELIVERY

- A. Bring materials to the job site in the original sealed and labeled containers.
- B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 – MATERIALS

2.01 GENERAL INFORMATION

- A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.
- B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared,

products were properly applied, and the paint systems were proper for the exposure and service.

- C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.
- D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.
- E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.
- F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
 - 1. Tnemec Company Inc.
 - 2. PPG
 - 3. Sherwin-Williams

PART 3 – EXECUTION

3.01 SHOP PAINTING

- A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

- B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

3.02 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.
2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.
3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.
4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.
5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.
6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.
7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Prepare all welds to a minimum NACE weld preparation level "C" per NACE Standard SP0178. Provide additional weld preparation where required by the coating manufacturer. Contractor shall provide NACE SP0178 weld mold visual aids on site for evaluation of all weld preparation.

2. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.
3. Perform blast cleaning operations for metal when following conditions exist:
 - a. Moisture is not present on the surface.
 - b. Relative humidity is below 80%.
 - c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.
 - d. Painting or drying of paint is not being performed in the area.
 - e. Equipment is in good operating condition.
 - f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.
4. Abrasive blast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.
5. Abrasive blast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service. Provide a 3.0 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
6. Abrasive blast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment. Provide a 1.5 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
7. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system. Abrasive blast clean to increase mechanical adhesion in accordance with ASTM D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting when required by coating manufacturer. Provide a 1.5 mil minimum angular anchor profile unless recommended otherwise by the coating manufacturer in writing.
8. Abrasive blast clean internal and external ductile iron pipe surfaces prior to coating in accordance with NAPF 500-03-04, Surface Preparations Standard for Abrasive Blast Cleaning of Ductile Iron Pipe. Abrasive blast clean internal and external cast ductile iron and cast-iron fitting surfaces in accordance with NAPF-03-05.

9. Prime cleaned metals immediately after cleaning to prevent rusting.
10. Clean rusted metals down to bright metal by abrasive blasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 28 days at 75° F before surface preparation, and painting begins. Allow more time at lower temperatures if specified by paint manufacturer.
2. Test concrete for pH and salts using test methods recommended by the paint manufacturer. A minimum of one test per 1000 square feet of area to be coated shall be performed unless approved otherwise by Engineer. Do not begin surface preparation, or painting until acceptable to manufacturer.
3. Moisture content of concrete and masonry surfaces shall conform to manufacturer's recommended limits, and as listed in SSPC-SP13/NACE 6 Section 6 Acceptance Criteria Table 1. Floor surfaces to be coated shall be tested in accordance with ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride or as required by the coating manufacturer. Moisture vapor transmission shall not exceed three pounds per 1,000 square feet in a 24-hour period or less if specified by Coating Manufacturer. Vertical and horizontal overhead surfaces shall be tested in accordance with ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete using in situ Probes (relative humidity shall not exceed 80% or as required by the coating manufacturer) or with ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Test Method (test results shall be no moisture present). Engineer or Coating Manufacturer Representative shall specify all test locations. A minimum of one test per 1000 square feet of area to be coated shall be performed unless approved otherwise by Engineer.
4. Prepare concrete surfaces to receive coatings in accordance with NACE 6/SSPC-13 – Joint Surface Preparation Standards and ICRI Technical Guidelines. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities using abrasive blasting, shot blasting, water jetting or mechanical abrading. Use dry, oil-free air for blasting operations. Surface texture after blasting shall achieve profile as required by manufacturer or where not defined by manufacturer, profile shall be a minimum ICRI-CSP 5 surface profile. Remove residual abrasives, dust, and loose particles by vacuuming or other approved method.
5. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may

be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.

6. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.
7. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.
8. To ease coating around outside corners, provide $\frac{3}{4}$ -inch chamfered edges on all new concrete outside corners and grind existing concrete outside corners to a minimum radius of $\frac{3}{4}$ -inch.
9. Unless recommended otherwise by the coating manufacturer, provide $\frac{1}{4}$ " deep by $\frac{1}{4}$ " wide tool cut terminations at 1-inch maximum from all coating edges for anchorage. Provide terminations around all equipment, piping, openings, gates, top and bottom of walls, stop locations of each day's work and overlap onto previously completed work. Transition coating 3-inches onto interior lining of piping except where coating compatibility concerns are noted by coating manufacturer.
10. Apply epoxy or polymeric filler compatible with painting system to all inside corners of areas to be coated with a margin trowel to form a continuous 45-degree cant cove across corners with a minimum dimension of 1.5-inch. Roughen or prepare cured filler as recommended by coating manufacturer for proper coating adhesion.
11. All equipment grouting shall be installed and cured prior to starting coating work. Coating shall be applied over grout up to the edges of all equipment, gates and uninterrupted piping unless specifically noted otherwise.

D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.
2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.
3. Prime and backprime wood trim before setting in place.
4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.
2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.
2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.
3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.
2. Remove dust, dirt, and other contaminants.

H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.
2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.
3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.
4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.
5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 APPLICATION OF PAINT

- A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.
- B. Apply paint without runs, sags, thin spots, or unacceptable marks.
- C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.
- D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.
- E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.
- F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.
- G. Suspend painting when any of the following conditions exist:
 - 1. Rainy or excessively damp weather.
 - 2. Relative humidity exceeds 85%.
 - 3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.
 - 4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.
 - 5. Surface temperature of item is within 5 degrees of dewpoint.
 - 6. Dew or moisture condensation are anticipated.
 - 7. Surface temperature exceeds the manufacturer's recommendations.
- H. Where application of coating across concrete control joints or expansion joints has the potential to crack, turn coating into joints and caulk joints with a sealant compatible with coating rated for the intended service per Section 07 90 00 – Joint Fillers, Sealants, Caulking.

3.04 INSPECTION

- A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.
- B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.
- C. Coatings shall pass a holiday detector test.
- D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.
- E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.
 - 1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Razor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - 2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Razor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.
- F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

- A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.
- B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 SCHEDULE OF COLORS

- A. Match colors indicated. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.07 WORK IN CONFINED SPACES

- A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state/commonwealth, and local regulations at all times.

3.08 OSHA SAFETY COLORS

- A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.
- B. Paint hazardous areas and objects in accordance with OSHA regulations.

PAINING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
<u>Concrete and Masonry</u>				
Interior masonry and concrete walls and ceilings	All new structures	1 coat sealer	101	75-85 sq.ft./gal.
		2 coats acrylic epoxy	116	4-6/coat
Interior masonry and concrete walls in chemical rooms		1 coat sealer	117	60-80 sq.ft./gal.
		2 coats epoxy polyamide	102	4-6/coat
Exterior masonry cavity walls on cavity face of inner wythe	All new structures	Dampproofing	See Section 07150	
Exterior below grade if interior is dry	Accessible areas (e.g. pipe galleries, pump rooms, basements, etc.)	Waterproofing	See Section 07100	
Submerged water	Water retaining side of new wall surfaces where opposite side of wall is interior and dry and where indicated "epoxy waterproofing" on drawing	2 coats NSF approved epoxy polyamide	105	4-6/coat
Submerged wastewater		2 coats high solids epoxy	119	6-10/coat
		Provide filler as required and recommended by manufacturer		
		Provide filler as required and recommended by manufacturer		
Containment Liner ¹	Interior and exterior secondary containment floors, tank supports and walls	2 coats high solids epoxy coating	119	6-10/coat
<u>Metals</u>				
Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer	104	4-6
		1 coat epoxy polyamide	102	4-6
		1 coat aliphatic polyurethane	115	3-5

Interior insulated		1 coat acrylic latex	103	4
Submerged water	All metal piping, and mechanical equipment, etc.	2 coats NSF approved epoxy polyamide	105	4-6/coat
Submerged Wastewater		2 coats high solids epoxy	119	8-10/coat
Steel doors, windows and door frames		1 coat epoxy polyamide	102	5-8
		1 coat aliphatic polyurethane	115	3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26
steel stairs, monorails, structural steel, misc. metals (steel)	Structural Steel, steel pipe supports and miscellaneous metals	Hot-Dipped Galvanized	See Section 05035	--
		1 coat epoxy polyamide	102	5-8
		1 coat aliphatic poly	115	3-4
<u>Other</u>				
Interior: Gypsum Wallboard	All new structures	2 coats acrylic latex matte or satin	103	2-3/coat
Interior: Tar-dipped piping where color is required		2 coats epoxy resin sealer	112	5-8/coat
		2 coats epoxy polyamide	102	5-8/coat
PVC Piping		1 coat epoxy polyamide	102	5-8
		1 coat aliphatic polyurethane	115	3-4

1. Painting manufacturer shall verify compatibility of containment liner and chemical to be contained. Where incompatible substitute a compatible coating system.
2. Clean Galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system prior to painting.

TABLE 9-2

PRODUCT LISTING

REF.	SYSTEM	PURPOSE	PRODUCT			
			<u>Tnemec Series</u>	<u>PPG/AMERON</u>	<u>CARBOLINE</u>	<u>Sherwin-Williams</u>
101	Acrylic filler	Primer-sealer	130-6601	BLOXFIL 4000	Sanitile 100	Cement-Plex 875
102	Epoxy polyamide	Finish coat semi-gloss or gloss	N69	AMERLOCK 2	Carboguard 890	Dura-Plate 235
103	Acrylic latex	Sealer	1028/1029	PITT TECH PLUS	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
105	Epoxy	Primer/Finish	20	AMERLOCK 2	Carboguard 561/56LT	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
109	Alkyd-long oil	Finish coat	1029	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	AMERLOCK SEALER	Rustbond	--
114	Polyamine Epoxy	Intermediate coat	27	AMERLOCK 385	Carboguard 893SG	--
115	Aliphatic Polyurethane	Finish coat	1074 or 1075	AMERCOAT 450 HS	Carbothane 134HG	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AQUAPON WB	Sanitile 255	Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	1254	AMERLOCK 114	Sanitile 600	Kem Cati-Coat HS Epoxy Filler
118	Catalyzed epoxy	Finish coat	84	AMERLOCK 2/400	Carboguard 890	Macropoxy 646
119	High solids epoxy	Finish coat	104	AMERLOCK 400	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	AMERLOCK 2/400	Carboguard 890	--

END OF SECTION

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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 for scope of work details as they relate to the Division 40 Subcontractor.

- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
 - 1. Furnish and install low voltage motor control equipment including variable frequency drives.
 - 2. Furnish and install power panelboards, lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.
 - 3. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.
 - 4. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.
 - 5. Furnish and install all low voltage wire and cable resulting in a complete and operable electrical system.
 - 6. Furnish and install new lighting systems and wiring devices.
 - 7. Other electrical work as specified herein and indicated on the Drawings.

- D. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must 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, including electrical equipment foundations, shall be designed to resist operational forces as well as lateral sway and axial motion from seismic and thermal forces.

1.02 EQUIPMENT LOCATION

- A. The Drawings show the general location of feeders, transformers, outlets, 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; furnishing 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. 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.

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 this specification section. 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 this Specification Section.

- E. Seismic support design for all nonstructural electrical components (conduit, raceways, freestanding equipment, etc.) shall be in accordance with all applicable federal, state/commonwealth and local building code requirements.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:
 - a. Insurance Rating Organization having jurisdiction
 - b. The serving electrical 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 material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the 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. Upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar 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 start-up and testing of all other equipment.

During the period between the completion of electrical installation and the start-up 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. The infrared inspection shall be performed by a third party, independent testing agency, not the Electrical Contractor.
- B. The infrared inspection shall apply to all new equipment and existing equipment 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. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor.
- 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 and IR pictures positioned side by side. Both the digital and IR pictures shall be clear and high quality. Fuzzy, grainy, or poorly illuminated pictures are not acceptable. The IR picture shall be provided with a temperature scale beside it, and an indication of the hot spot temperature in each picture. 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 notify the Engineer six (6) weeks in advance of the scheduled date for the protective device setting and testing. The testing firm shall submit to the Engineer a tabulated listing of all protective devices requiring setting six (6) weeks prior to the setting and testing date. 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 must be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer must 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 must 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 MATERIALS HANDLING

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as 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.

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, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

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 standard detail for equipment pads shown on the Contract Drawings. Equipment pads shall not have more than 3" excess concrete beyond the edges of the equipment.

2.04 RUBBER INSULATING MATTING

- A. Rubber insulating matting shall be furnished and installed on the floor and in front of each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. 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.

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

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 and 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 Section 26 05 00 – Basic Electrical Requirements and Section 26 05 33.16 – Boxes for Electrical Systems.

1.02 CODES AND STANDARDS

- A. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. 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 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
 - e. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords
 - f. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
 - g. UL 2250 – Standard for Instrumentation Tray Cable
 - h. UL 2556 – Wire and Cable Test Methods
 - 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. Institute of Electrical and Electronics Engineers (IEEE)
- a. IEEE 1202 – Standard for Flame Testing of Cables

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
- 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
 - b. Power and control wire terminations
 - c. Instrumentation cable terminations
 - d. Shielded VFD cable terminations
 - e. 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 and cable is size #1/0 AWG and larger.
- B. Cable pulling calculations shall be performed by a currently registered Professional Engineer in the State or Commonwealth in which the project is located and 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. Only one (1) manufacturer for each wire and cable type shall be permitted.

2.02 POWER AND CONTROL WIRE AND CABLE

- A. Power wire installed between the output terminals of a VFD and the respective motor shall be shielded VFD cable as specified herein.
- B. Power wire for all other loads 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.
- C. 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. Power conductors for lighting and receptacle branch circuits shall be solid copper per ASTM B-3.
- D. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.
- E. 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).
- F. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or 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 equal.

2.04 SHIELDED VFD CABLE

- A. Where indicated on the Drawings, shielded VFD cable shall be installed between the output terminals of a VFD and the respective motor.
- B. Shielded VFD cable shall consist of three (3) individually insulated copper phase conductors and three (3) bare copper grounding conductors with an overall cable shield and jacket, suitable for use with variable frequency drives. The phase conductors and ground conductors shall be symmetrically arranged within the cable assembly. Conductor insulation shall be rated 90°C in both wet and dry locations, and 2000V (2kV). Insulated conductors shall be UL Listed as NEC Type RHW-2 or XHHW-2. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL Listed as NEC Type TC-ER (Tray Cable for Exposed Runs).
- C. Phase conductors shall be sized as shown on the Drawings. Ground conductors shall have a combined circular mil area equivalent to one phase conductor, minimum. Filler material shall be included in the cable assembly as necessary to make the cable round.
- D. Cable shields shall consist of a helically applied bare copper tape with 50% overlap, minimum. For small conductor sizes where copper tape shields are not available, shields shall be permitted to consist of a layer of tin-coated copper braid covered by a layer of overlapped aluminum/polyester tape/foil. All cable shields shall provide 100% coverage.
- E. Conductors shall be annealed, tinned, stranded copper per ASTM B3, B8, and B33.
- F. Shielded VFD cable shall be as manufactured by Belden Wire and Cable, the Okonite Company, General Cable, Southwire, or AmerCable Inc.

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. 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.
2. 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.
3. 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.
4. 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 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 of 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 particular conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle by the use of 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. 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.
3. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.
4. Shielded VFD cables shall be terminated with kits required by or recommended by the approved shielded VFD cable manufacturer. Termination kits shall be installed in strict accordance with the shielded VFD cable manufacturer's and termination kit manufacturer's instructions.
5. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.
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.

3.02 FIBER OPTIC CABLE INSTALLATION

- A. The Contractor shall install the fiber optic cable furnished by the General Contractor and/or the Instrumentation and Control Subcontractor. The cable shall be installed in its respective raceway system(s) as specified herein, indicated on the Drawings, and in accordance with the cable manufacturer's instructions. Reference Division 40 for additional information regarding the fiber optic cable.

3.03 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. _____

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:

END OF SECTION

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 minimum 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. UL 467 – Grounding and Bonding Equipment
 - 2. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - 3. IEEE 1100 – Recommended Practice for Power and Grounding Electronic 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 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 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 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 exothermically welded to the rods. 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 "pigtailed" shall be connected to the ground grid and shall enter the buildings and structure from the outside and shall be connected to steel structures, and equipment as described in this Section and as required to provide a complete grounding system. The copper pigtailed shall be 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 exothermic welds and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, 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 IEEE81 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

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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 conduit, electrical equipment, lighting, alarm systems, instrumentation, 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. 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. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - 3. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 4. ASTM A276 – Standard Specification for Steel Bars and Shapes
 - 5. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts

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 (if required)

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 gage 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 or 316 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 or 316 Stainless Steel
All Outdoor Areas	Type 304 or 316 Stainless Steel
All Hazardous Areas	Type 304 or 316 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 or 316 Stainless Steel
Indoor Dry Process Area	Type 304 or 316 Stainless Steel
Indoor Dry Non-process Area	Type 304 or 316 Stainless Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 or 316 Stainless Steel
All Outdoor Areas	Type 304 or 316 Stainless Steel
All Hazardous Areas	Type 304 or 316 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. All 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 registered Professional Engineer 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 registered Professional Engineer 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 ½” 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 and conduit fittings to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Section 26 05 29 – Hangers and Supports for Electrical Systems, for these requirements.
- C. Reference Section 26 05 00 – Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Conduits and conduit fittings shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B1.20.1 – Pipe Threads, General Purpose
 - b. ANSI C80.1 – Electrical Rigid Steel Conduit
 - c. ANSI C80.5 – Electrical Rigid Aluminum Conduit
 - d. ANSI FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
 - 2. 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 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations
 - i. UL 1479 – Standard for Fire Tests of Penetration Fire Stops
 - j. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit
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 Electrical Contractors Association (NECA)
- a. NECA 1 – Standard for Good Workmanship in Electrical Construction
5. Others
- a. ACI-318 – Building Code Requirements for Structural Concrete

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. Product data sheets for conduits and fittings.
 - 2. Conduit identification methods and materials.
 - 3. 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. 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.
- B. Conduit categories are indicated on the Drawings by the leading letter of the conduit tag. Conduit tag leading letters are defined as follows:
 - 1. P – Power Conduit
 - 2. C – Control Conduit
 - 3. I – Instrumentation Conduit

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 I

hazardous areas shall be UL 1203 Listed. 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 I hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a 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 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 $\frac{3}{4}$ 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 I 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 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 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 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.

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 I 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

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. 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 I 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 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 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 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

2.08 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 between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.

2. 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.

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. The sealing of the inside of 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 Rayflate 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 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.

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.
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 3/4 inch in exposed applications and 1 inch in embedded 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 ¾ 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:
 - 1. Instrumentation conduits installed parallel to conduits with conductors energized at 480V or above shall be 18 inches.
 - 2. Instrumentation conduits installed parallel to conduits with conductors energized at 240V and below shall be 12 inches.
 - 3. Instrumentation conduits installed at right angles to conductors energized at 480V and below shall be 6 inches.
 - 4. Instrumentation conduits installed at right angles to conductors energized at voltages above 480V shall be 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 containment areas without specific written authorization from the Engineer. Liquid containment areas are indicated on the Drawings.
- N. 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.
- O. 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.
- P. 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.
- Q. 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.

- R. 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.
- S. 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. Conduits shall not be installed embedded within any liquid containment area floors or walls.

2. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to Class I and II hazardous areas (Division I and Division II).
3. 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 aluminum 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	Rigid aluminum conduit	Same as Power and Control
Exposed in outdoor areas	Rigid aluminum conduit	Same as Power and Control
Concealed within underground direct-bury or concrete-encased ductbanks	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	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material)	Schedule 40 rigid non-metallic PVC conduit	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 concrete walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within CMU walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
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 I and Division II)	Rigid aluminum conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas (Division I and Division II)	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 I and Division II)	Rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete walls in Class I and II areas (Division I and Division II)	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 I areas	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed above suspended ceilings in Class I and II areas (Division I and Division II)	Rigid aluminum 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 fiber optic cable.
 - b. All conduits containing shielded VFD cable.
 - c. 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

- 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	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Liquid-tight 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
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

5. For Class I Division I 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 II areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in Class II (Division I and Division II) areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings in Class I and II (Division I and Division II) areas	Same material as exposed conduit in same area	Same as Power and Control

3.04 CONDUIT FITTING USES AND APPLICATIONS

A. General

1. 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.
2. 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 ¼ 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. All conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.
2. All conduit penetrations through interior walls and floors shall be sealed through the use of with conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit periphery.
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. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: RAS Pump No. 1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g. FROM: MCC-RAS). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18-point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24-point font.
 4. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
 5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
 6. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.
- B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:
1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
 2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
- C. Conduits for lighting and receptacle circuits shall not require identification.
- D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

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 RGS conduit shall be trained by the PVC coated RGS 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 scope of work under this Section includes furnishing and installing all pull boxes, junction boxes, and outlet boxes.
- B. Requirements for other boxes and enclosures are not included in this Section. Reference each specific equipment Section for requirements related to that equipment's respective enclosure.
- C. Reference Section 26 05 00 – Basic Electrical Requirements and Section 26 05 33.13 – Conduit for Electrical Systems.

1.02 CODES AND STANDARDS

- A. Boxes shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 514A – Metallic Outlet Boxes
 - 2. UL 514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers
 - 3. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations
 - 4. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations
 - 5. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - 6. NEMA 250 – Enclosures for Electrical 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(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

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 where shown 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 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 or 316 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
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 or 316 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 or 316 Stainless Steel

2. 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 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel

Area Classification	Enclosure Type and Material
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, 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.

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

- 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 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, 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

1. 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.
2. 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.
3. 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.
4. 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. For the below-named items, mounting heights from finished floor, or finished grade to top is applicable, depending on the type of wiring device to be installed in the outlet box. Mounting heights for outlet boxes shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):
 - a. Light switches and wall mounted occupancy sensors, 48 inches
 - b. Receptacles in indoor dry process/non-process areas, 16 inches
 - c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 48 inches
 - d. Receptacles in outdoor locations, 24 inches

- e. Ceiling mounted occupancy sensors, as indicated on the Drawings
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 switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull and junction boxes, enclosures, disconnect switches, control stations, and similar 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 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 equal.

2.03 HIGH VOLTAGE SIGNS

- A. Standard "DANGER" signs shall be of baked enamel finish on 20 gage 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 (2) two 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 (i.e. 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 – Submittals, 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, alkalis, 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 a through m as listed in Article 1.04 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, non-ventilated (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. Spare 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

**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
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
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

**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
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
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. Field Tests
 - 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.
 - b. 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" on following page.
 - c. All field testing shall be witnessed by the Engineer.

(EXHIBIT A)

MOTOR TEST RECORD					
Motor Identification Remarks	Location	Specified Horsepower	Nameplate Horsepower	Nameplate Amperage (FLA)	Measured Amperage Under Normal Operating Conditions

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 Section 26 05 00 – Basic Electrical Requirements and Section 26 05 53 – Identification for Electrical Systems.

1.02 CODES AND STANDARDS

- A. Products specified herein shall be in conformance with or listed to the following standards as applicable:
 - 1. NEMA 250 – Enclosures for Electrical Equipment
 - 2. UL 508A – Standard for Industrial Control Panels
 - 3. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - 4. ANSI/ISA 12.12.01-2013 – Nonincendive Electrical Equipment for use in Class I and II, Division II 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. The 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.
- C. 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.
- D. Spare parts lists, included with the shop drawing submittal, 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.
- E. Parts shall be completely identified with a numerical system to facilitate parts 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 part number.

PART 2 – PRODUCTS

2.01 CONTROL COMPONENTS

A. Manufacturers

1. Control components shall be manufactured by Eaton, The Square D Company, General Electric, 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 (i.e. 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 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 (i.e. 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 or 316 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 or 316 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 or 316 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 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 304 or 316 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, 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.
- F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class 1 Division 1 and Class 2 Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class 1 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. 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.
- C. 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 bonding screw shall be bonded to the equipment enclosure through the use of an insulated green bonding conductor.
- D. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.
- E. 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.
- F. 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 and install panelboards of voltage and current ratings as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles and locations conforming to the panelboard schedules on the Drawings.
- B. Reference Section 26 05 00 – Basic Electrical Requirements; Section 26 05 53 – Identification for Electrical Systems; and Section 26 43 13 – Surge Protective Devices

1.02 CODES AND STANDARDS

- A. Panelboards shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. Underwriters Laboratories
 - 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
 - 2. NEMA PB1 – Panelboards
 - 3. National Electrical Contractors Association (NECA) Standard 407 – Standard for Installing and Maintaining Panelboards

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-RAS 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. Spare parts lists 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. 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.

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.

2.02 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 shall be suitable for outdoor use and be provided in a NEMA 3R 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.
- D. The combination power unit shall be a Mini-Power Zone as manufactured by the Square D Company, a Mini-Power Center as manufactured by Eaton, Servicecenter as manufactured by General Electric Company, or Siemens Energy and Automation, Inc. equivalent.

2.03 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. See Section 26 43 13 – Surge Protective Devices for SPD requirements.
- 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. 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 megaohmmeter 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 24 19
LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, test, and place in satisfactory operation, the motor control centers as specified herein and indicated on the Drawings.
- B. The Contractor shall obtain the motor control centers from one manufacturer who shall also manufacture the enclosure and major equipment components, which includes, but is not limited to, combination starters, variable frequency drives, circuit breakers, power monitoring equipment, and other components of the equipment assembly. Subcontracting of wiring is not acceptable.
- C. The motor control center 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.
- D. Reference Section 26 05 00 – Basic Electrical Requirements; Section 26 05 53 – Identification for Electrical Systems; Section 26 29 23 – Low-Voltage Variable Frequency Motor Controllers; Section 26 43 13 – Surge Protective Devices, and Section 26 09 16 – Electric Controls and Relays.

1.02 CODES AND STANDARDS

- A. The assemblies shall meet or exceed the requirements within the following standards for motor control centers:
 - 1. NEMA ICS-18
 - 2. UL845
- B. The motor control center shall be designed, manufactured, and tested in facilities registered to the following quality standards:
 - 1. ISO 9001

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. Proposed Testing Methods and Reports of Certified Shop and Field Tests.
4. Manufacturers Startup Certification
5. Operation and Maintenance Manuals.

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 motor control center shall include but not be limited to:
 1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E 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 this Specification Section. 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 this Specification Section.
 2. Product data sheets.
 3. Example equipment nameplate data sheet.
 4. Approximate total shipping weight of each shipping split.
 5. Plan, front, and side view drawings, including overall dimensions of each motor control center. Identify shipping splits and show conduit stub-up area locations on the Drawings.

6. Internal schematic and point-to-point wiring diagrams of each motor control unit including variable frequency drives integrated into the motor control center. Standard wiring diagrams that are not custom created by the manufacturer for the motor control centers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. RAS Pumps) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.
 7. Complete single-line diagrams for each motor control center showing circuit breakers, motor circuit protectors, motor controllers, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete assembly. Indicate electrical ratings of equipment and devices on these single-line diagrams. Ratings include starter size and type, motor circuit protector continuous current rating, circuit breaker frame size and trip rating, motor horsepower and full load current, and similar information.
 8. Bill of material list for each motor control center and each motor control unit.
 9. Nameplate schedule for each motor control center.
 10. Manufacturer's installation instructions.
 11. Key interlock scheme drawing and sequence of operations.
 12. Manufacturer's Warranty Statement
 13. Table listing all motor loads connected to the motor control center. Table shall include the full load amps of the APPROVED motors. Final approval of MCC shop drawings cannot be given until all motor loads for MCC have been reviewed, approved, and shown in this table.
- 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.
- E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each motor control center unit of each motor control center. These final drawings shall be included in the O&M manuals.

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. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts for each motor control center:
1. One (1) set of fuses of each size provided
 2. One (1) starter coil and complete set of contacts for each size and type of starter provided
 3. One (1) relay of each type and size provided
 4. One (1) control power transformer of each size provided
 5. Two (2) lamps and lenses for indicating lights for each color provided
 6. One (1) indicating lamp socket for each type provided
 7. One (1) pilot device (e.g. pushbutton, selector switch, etc.) complete with contact blocks and legend plates for each type, size, and rating provided
 8. One (1) motor circuit protector for each type, size, and rating provided
 9. One (1) circuit breaker for each type, size, and rating provided (except main circuit breakers)
- B. The 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.
- C. 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.
- D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Term such as "1 lot of packing material" are not acceptable.
- E. Parts shall be completely identified with a numerical system to facilitate parts 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.

1.07 IDENTIFICATION

- A. Each motor control center shall be identified with the identification number indicated on the Drawings (e.g., MCC-RAS, etc.). A nameplate shall be securely affixed in a conspicuous place on each motor control center. 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.
- B. It is the intent of these specifications that all components of the motor control center be provided by one manufacturer who shall have the sole responsibility of matching all components and providing equipment which functions together as a system. The manufacturer of the motor control center shall also be the manufacturer of the motor controllers. The use of third-party supply and assembly of these components is not acceptable.
- C. Motor control centers shall be Freedom 2100 as manufactured by Eaton using NEMA rated Freedom Series contactors and starters, Model 6 as manufactured by the Square D Company, Centerline 2100 as manufactured by Allen-Bradley, Tiastar as manufactured by Siemens Energy and Automation Inc., or the General Electric Company Evolution Series E9000. No substitutions allowed.

2.02 MOTOR CONTROL CENTER

- A. General
 - 1. The motor control centers shall be 600 VAC class suitable for operation on a three-phase, 60 Hz system. The motor control centers and their components shall conform to the requirements of applicable standards of NEMA Part ICS 2-322 and Underwriters' Laboratories, Inc. UL-845. Wiring shall be NEMA Class II, Type B. Each vertical section shall be a NEMA 4X outdoor industrial use enclosure unless otherwise specified or indicated on the Drawings.
 - 2. The enclosures shall be cleaned, primed, and finish coated in accordance with the manufacturer's standard process. The pre-treatment process shall be a zinc chromate primer followed by a "One Coat" paint process that is monitored to meet the manufacturer's specifications for paint color, texture, thickness, and durability. Enclosure interior and exterior finish color shall be ANSI 49 (medium light gray).

The color of the back panel/bucket located within the MCC enclosure shall be white.

3. The motor control centers shall be capable of withstanding the fault current available at its line terminals. Minimum bus bracing, withstand, and interrupting ratings are specified herein.
4. Unless otherwise specified or indicated on the Drawings, each vertical section shall be approximately 20 inches wide, and 90 inches high, 20 inches deep, and shall not contain more than six NEMA Size 1 starters. Motor control centers shown "back-to-back" on the Contract Drawings shall be complete motor control assemblies placed back-to-back in the location shown. Motor control center sections with common horizontal and/or vertical bus systems are unacceptable.
5. Continuous horizontal wiring troughs shall be provided at both the top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the motor control center. Each section shall be provided with a large, continuous, full height vertical wiring trough in the right side of each section. Each vertical wiring trough shall be furnished complete with tie bars for conductor support.
6. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105°C. Wire color coding shall be red for control and black for power. Wire numbers shall not be repeated in a motor control center.
7. Starter units shall contain the number of auxiliary contacts, unit-mounted pilot devices and indicating lights, control relays, elapsed time meters, and other devices as shown on the Drawings and required for the applications. A minimum of two (2) normally open (NO) and two (2) normally closed (NC) spare contacts shall be provided for each magnetic starter. These spare contacts shall be shown on the submittal wiring diagrams.
8. The motor control centers shall be furnished with warning signs to notify maintenance personnel of multiple sources of power within the motor control units.
9. Outdoor motor control centers shall be provided with thermostatically controlled strip heaters.

B. Power

1. The motor control centers shall be supplied from a 480V, 3-phase, 3 or 4 wire as indicated on the Drawings, 60 Hz power source. The incoming power feeders shall be sized as shown on the Drawings. All terminals for incoming and outgoing power cables shall be provided with compression lugs.

C. Bus

1. Power shall be distributed by means of a continuous, tin plated copper horizontal bus, rated as shown on the Drawings. The bus shall be braced for 65,000A rms symmetrical at 480V unless otherwise indicated on the Drawings. The horizontal bus shall be effectively isolated from all wiring troughs and other working areas. Vertical bus extensions shall be tin plated copper, isolated by rigid, glass-polyester moldings so as to be a separate self-supported assembly. Silver plated vertical bus may be provided if specifically accepted by the Engineer. Full height vertical bus shall be installed in all sections including those containing spare units and "prepared" spaces. No extra safety jacks or similar devices shall be required to obtain an essentially dead-front condition. Access shall be provided for inspection and maintenance from the front. Minimum horizontal bus rating shall be 600A. Minimum vertical bus rating shall be 300A.

D. Incoming Line Units

1. Each incoming line unit shall contain buswork and fittings as required with cable lugs for cables of sizes and quantities shown on the Drawings. Cable lugs shall be suitable for their respective conductors.
2. A neutral landing pad shall be furnished in the main circuit breaker section. A neutral landing pad is required to terminate the grounded conductor from the utility transformer in accordance with the NEC.

E. The Unit Compartments

1. Each unit compartment shall be provided with an individual front door hinged to the vertical structure. Each plug-in unit shall be supported and guided by a removable unit support pan, so that the unit rearrangement is easily accomplished. The rearrangement of the unit support pan from one location to the other shall be accomplished without use of tools. After insertion, each plug-in unit shall be held in place by at least one multi-turn latch, located at the front of the unit. The latch shall be located for front accessibility and installation convenience. An additional mechanical interlock shall be provided to prevent withdrawal of the unit from the stationary structure with the operating mechanism in the ON position.
2. The unit plug in power stabs shall be electromagnetically tin-plated copper to yield a low resistance connection and designed to tighten during heavy current surges and short circuits. The stab shall be backed by spring steel clips to provide and maintain a high pressure, two-point connection to the vertical bus. They shall be free floating and self-loading plug-in. Wiring from the unit disconnecting means to the plug-in stab shall be exposed at the rear of the unit. The power cable terminations at the plug-in stab shall be mounted in a two-piece, glass polyester support assembly. This support assembly shall provide a separate isolated

pathway for each phase, minimizing the probability of a unit fault condition reaching the power bus system.

3. NEMA Size 1 through Size 5 non-reversing starters shall be plug-in units. Size 1, 2, and 3 shall utilize stab assembly rated 100A. Stab assemblies for Size 4 and Size 5 starters shall be rated for the starters maximum output current rating.
4. An industrial, heavy-duty flange handle mechanism shall be supplied for the control of each disconnecting means. This mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position. The operator handles shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8 inch diameter shackle padlock.
5. The operator handle of all units shall be interlocked with the door units so that the disconnect means cannot be switched unless the door unit is closed. A means shall be provided for purposely defeating the interlock during maintenance or testing. This interlock shall also prevent opening the unit door unless the disconnecting means is in the off position. An externally operated def eater requiring the use of a screwdriver shall provide access to the unit without interrupting service.
6. The overload relays shall be resettable from the outside of the enclosure by means of an insulated bar or button.

F. Ground Bus

1. The horizontal ground bus shall be tin plated copper and located in the bottom horizontal wireway. The minimum size of the horizontal ground bus shall be ¼-inch x 1 inch (6.35mm x 25.4mm) or 33% of the phase bus ampacity, whichever is greater.
2. Compression lugs shall be mounted on the ground bus in each section, in the size and quantity as required for the termination of system and equipment grounding conductors.
3. The vertical ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. This ground bus, in combination with the unit ground bus stab, establishes unit grounding before the plug-in power stabs engage the power bus, and conversely, as the unit is withdrawn, grounding is maintained until after the plug-in power stabs are disengaged.
4. The vertical load ground bus shall be tin plated copper and solidly connected to the horizontal ground bus. The vertical load ground bus assembly, comprised of the vertical load ground bus and the unit load ground bus connector, shall provide

a termination point for the load equipment grounding conductor at the unit. This fixed connection shall not have to be removed when the unit is withdrawn from the motor control center.

G. Isolation and Insulation

1. Horizontal bus access covers and vertical bus covers shall isolate the energized buses to guard against the hazard of accidental contact. These covers shall be molded of a glass polyester material.
2. The horizontal bus shall be isolated from the top horizontal wireway by a grounded steel barrier. This barrier shall be removable to allow access to the bus and connections for maintenance.
3. The vertical bus cover shall provide unit plug-in openings which shall permit unit plug-in stab assemblies to pass through and engage the vertical bus. The unit plug-in openings shall be sized to minimize the probability of inadvertent contact with the vertical bus.
4. Isolation of unused stab openings shall be accomplished by use of a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the motor control center.
5. All units shall be isolated from one another, above and below, by unit support pans or steel barriers, which can remain in place when the units are withdrawn.
6. Incoming line compartments shall be isolated from horizontal and vertical wireways by steel barriers.
7. A molded unit isolating barrier shall be provided to isolate the unit from the vertical wireway.

H. Combination Motor Control Units

1. Motor branch circuits shall be protected by a motor circuit protector (MCP).
2. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.

3. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.
4. The motor circuit protectors in combination with a contactor and overload relay shall have an interrupting rating that matches the motor control center short circuit rating at 480V.
5. Motor circuit protector's ratings, modifications, etc., shall be as specified herein and as indicated on the Drawings.
6. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

I. Motor Starters

1. Motor starters shall conform to NEMA Standard IC1 and shall be for across-the-line starting, unless otherwise indicated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment. The size of the starter shall be as required for the particular load. Minimum starter size shall be NEMA Size 1. Size 1 and 2 starters shall be completely drawout type, so that units may be withdrawn without disconnecting any wiring. Size 3 and 4 full-voltage, non-reversing starters shall be drawout type after disconnecting power leads only. Starters over three-space units high may be bolt-on type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in deadfront openings in vertical power bus.
2. A suitable control disconnect device(s) to comply with the requirements of the NEC shall be provided.
3. Magnetic starters and contactors shall be electromagnetic vertical or horizontal lift design with double break cadmium oxide silver contacts. Design shall meet or exceed the requirements of UL and NEMA Standards. Coils shall be hot molded construction to protect the coils from mechanical and environmental damage.
4. Each starter shall be able to accommodate a minimum of three (3) auxiliary contacts in addition to the hold-in contact.
5. Each starter shall be supplied with a 3-pole, manual reset overload relay. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall

be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy or bi-metallic type overload relays are not acceptable.

6. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid-state equipment (e.g. programmable logic controller) wired as part of the control circuit.
7. The Contractor and motor control center manufacturer is advised to review the Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides. The minimum control power transformer VA requirements are shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.
 - a. Size 1-75 VA
 - b. Size 2-75 VA
 - c. Size 3-200 VA
 - d. Size 4-300 VA
 - e. Size 5-500 VA

J. Circuit Breakers

1. Where specified herein, indicated on the Drawings, or required, the main circuit breaker shall be rated for service entrance and bear a service entrance label.
2. Unless otherwise indicated, circuit breakers shall be manually operable and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous short-circuit protection.
3. Circuit breakers shall be molded case type, rated 480 VAC, 2 or 3 pole and have 100 ampere or larger frames. The interrupting rating shall match that of the motor control center short circuit rating at 480V.
4. Overload protection shall be provided on all poles with trip settings as indicated on the Drawings. Breakers of 225-ampere frames and larger shall have interchangeable trip units and adjustable magnetic trip elements.

5. Horizontally mounted operator handles for feeder circuit breaker units up to 225A are permissible if accepted in writing by the Engineer.
6. Where indicated on the Drawings, shunt trip devices shall be provided to trip a circuit from a remote location by means of a trip coil energized from a separate circuit. A 120V shunt trip shall be capable of operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

K. Terminal Blocks

1. Terminal blocks associated with removable units within the motor control center shall be provided as follows:
 - a. Terminal blocks shall be mounted within the unit insert and in the front for ease of accessibility.
 - b. Pull-apart style terminal block assemblies shall be provided. Terminal block assembly shall consist of a male and female component held together with captive screws. The terminal block assembly shall be designed to withstand the effects of vibration, yet able to be pulled apart without difficulty. The terminals of the assembly shall be recessed to isolate them from accidental contact. Terminal markings shall be provided for the purpose of identifying terminations. Terminal strips shall be suitable for use as a disconnecting means of foreign interlock voltages.
 - c. For starters Size 2 and smaller, terminate all starter wiring (power and control) and external field wiring on terminal blocks provided in each unit.
 - d. For starters Size 3 and larger, terminate control wiring and external field control wiring on terminal blocks provided in each unit.
2. Terminal blocks associated with non-removable units within the motor control center shall be provided in accordance with Section 26 09 16 – Electric Controls and Relays.
3. Provide a minimum of four (4) spare terminals in each terminal block assembly.

L. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 26 09 16 – Electric Controls and Relays:
 - a. Pilot devices (switches, indicating lights, etc.)
 - b. Relays and timers

M. Nameplates

1. Provide engraved plastic nameplates to identify the motor control center, each unit compartment, door mounted devices, and internal components.
2. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems. Equipment names and numbers as indicated on the single line diagrams shall be used as the basis to engrave the nameplates.
3. Provide a master nameplate giving motor control center designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
4. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

N. Future Space Requirements

1. Provide spaces for future combination starter and other units in the motor control centers. Furnish spaces with hardware to accommodate future plug-in control unit without modification of vertical sections. Provide the number of spaces required for future units as indicated on the Drawings, minimum.
2. Provide additional vertical sections to ensure total number of spaces as indicated on the Drawings. The number of vertical sections is contingent upon specific manufacturer's final proposed and Engineer-accepted configuration of motor control center units.

O. Motor Control Center Additions

1. The Contractor shall furnish and install complete motor control center sections or individual motor control center units to be added to existing motor control centers in accordance with these Specifications and as indicated on the Drawings.
2. These additions shall be of the same manufacturer, type, rating, and color as the existing motor control centers. Furnish and install all hardware necessary to connect the buses of the new and existing motor control centers, including ground buses. Enclosures shall match existing.

P. Motor Control Center Modifications

1. The Contractor shall modify existing motor control centers and specific motor control center units as specified herein and indicated on the Drawings. These modifications include, but are not limited to, additions of door mounted pilot devices, modifications to existing motor control circuits and other work. The

Contractor shall reference Section 40 61 96 – Process Control Descriptions for specific information regarding these modifications.

Q. Metering

1. Each motor control center assembly shall be furnished and installed with an Eaton Power Xpert 4000 power quality meter and graphic display module or Allen-Bradley equivalent PowerMonitor 3000 with display module as indicated on the Drawings. A communication expansion card to support Ethernet communication to the plant control system and a 1GB memory card shall be provided with each meter.

R. Surge Protective Devices

1. Surge protective devices (SPD) shall be provided either integral to the MCC enclosure. See Section 26 43 13 – Surge Protective Devices for SPD requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The motor control centers shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. Install motor control centers to allow complete unit door swing required for unit removal. This is specifically required where a vertical section of motor control center is set next to a wall to the left of the motor control center section.
- C. Where motor control center structures are located away from walls to allow bottom conduit entry, the Contractor shall furnish and install sheet metal coverings for openings along the sides and top of the motor control center line-up. The purpose of the coverings is to minimize dust, dirt, and undesirable materials from collecting behind the equipment. The sheet metal coverings shall be of the same material, gauge, and finish as the motor control center.
- D. Motor control centers shall be furnished with anchor bolts as required for aligning and mounting. Floor channels with end covers shall be of type recommended by the manufacturer and shall be furnished for installation in a concrete pad.
- E. All field wiring that is terminated directly to a unit within the motor control center shall be neatly routed in a manner that does not hinder the ability to service, adjust, or replace components within that unit. Field wiring shall be properly anchored to the motor control center and individual unit structures.

- F. 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. Witnessed Shop Tests
 - a. None required.
 - 2. Certified Shop Tests and Reports
 - a. Submit description of proposed testing methods, procedures, and apparatus. Submit notarized and certified copies of all test reports.
 - b. As a minimum, the entire motor control center 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 and the electrical conductors including bussing, general wiring, and units.
 - 2) General electrical tests including power circuit phasing, control circuit wiring, instrument transformers, meters, ground fault system, and device electrical operation.
 - 3) AC dielectric tests of the power circuits and control circuits.
 - 4) Markings/labels, including instructional type, Underwriters Laboratory (UL), and inspector's stamps.
 - 3. The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the motor control center.
- B. Field Tests
 - 1. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

3.03 FIELD ADJUSTMENTS

- A. All adjustable settings of circuit breakers shall be set in the field by a qualified representative of the manufacturer, or an outside testing company retained by the Contractor, in accordance with the settings designated in the coordination study. See Section 26 05 00 – Basic Electrical Requirements.
- B. The settings of the motor circuit protectors and overload relays shall be set based on the coordination study and the motor nameplate data of the motors installed.

3.04 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified, factory-trained manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.
- B. The manufacturer's technical representative shall perform startup and functional testing of the equipment as specified herein.
- C. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for one (1) sessions of two (2) hours. Training shall be at times coordinated with the Owner. Training shall be provided in accordance with the requirements of Section 46 00 00 – Equipment General Provisions.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
 - 1. One (1) trip of one (1) working day during the installation and startup of the equipment.
 - 2. One (1) trip of one (1) working day two (2) months before the warranty expiration to identify any issues to be corrected under warranty.
 - 3. One (1) trip of one (1) working day to perform training as specified herein.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

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, occupancy sensors, 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. Wiring devices shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 20 – General Use Snap Switches
 - 2. UL 498 – Standard for Attachment Plugs and Receptacles
 - 3. UL 943 – Ground Fault Circuit Interrupters
 - 4. 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. Spare parts lists, included with the shop drawing submittal, 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. 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.

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 (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. All 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. Devices 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, Crouse-Hinds #DS185, or equal for wall switches. Device plates for receptacles shall be “in-use” style. “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 equal.

- C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32, or equal for switches, and Crouse-Hinds DS23 or 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 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 interrupter type. Ground fault circuit interrupter 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 and install 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.

1.02 CODES AND STANDARDS

- A. Disconnect switches shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. UL 98 – Enclosed and Dead-Front Switches
 - 2. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.
 - 3. NEMA 250 – Enclosures for Electrical Equipment
 - 4. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches

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. Spare parts lists, included with the shop drawing submittal, 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.
- D. 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.

1.06 IDENTIFICATION

- A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated. 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 General Electric Company, 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. 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 or 316 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 or 316 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 or 316 Stainless Steel

- E. 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 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. All disconnect switches shall be mounted five (5) feet above the floor or finished grade, at the equipment height where appropriate, 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.

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

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SECTION 26 29 23
LOW VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFDs) as specified herein and indicated 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
 - 3. Section 26 24 19 – Low Voltage Motor Control Centers
 - 4. Section 26 43 13 – Surge Protective Devices
 - 5. Section 26 09 16 – Electric Controls and Relays
- C. The Contractor is responsible for coordinating with the driven equipment manufacturer and the VFD manufacturer to ensure that the VFD is sized properly to meet all of the requirements herein. This includes, but is not limited to, accounting for motor RPM and variable or constant torque applications. The Contractor is responsible for including any costs related to equipment upsizing, conduit and wire upsizing, etc. that results from selecting equipment with a higher full load amp rating than was specified or used as the basis for design.
- D. The variable frequency drives 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.

1.02 CODES AND STANDARDS

- A. VFDs shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. NEMA 250 – Enclosure for Electrical Equipment
 - 2. IEEE 519 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

3. NEMA ICS 7 – Adjustable-Speed Drives
4. NEMA ICS 61800-2 – Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems
5. UL 508A – Standard for Industrial Control Panels
6. UL 508C – Standard for Power Conversion Equipment

1.03 DEFINITIONS

- A. The following definitions are provided for clarity with regard to the language used in this Specification:
 1. Variable Frequency Drive (VFD) – The complete custom-engineered VFD as packaged within an overall enclosure, including the VFD unit and all other components within that enclosure as specified herein.
 2. VFD Unit – The solid-state power electronic device or devices within the VFD.

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in General Conditions and Section 01 30 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 and Field Tests
 5. Manufacturer's Field Start-up Report
 6. Manufacturer's Representative's Installation Certification

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 **for each VFD** shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E 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 this Specification Section. 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 this Specification Section.
2. Complete bill of material and catalog data sheets for all equipment and devices comprising the VFD.
3. Product data sheets for **all** system components, including but not limited to:
 - a. VFD units
 - b. Harmonic correction devices and/or equipment, e.g. line reactors, passive filters, and 18-pulse phase-shifting transformers
 - c. Output reactors and/or output filters
 - d. Pilot lights and pilot devices
 - e. Control and timing relays
 - f. Enclosure fans
 - g. Contactors
 - h. Power supplies
 - i. Control power transformers
 - j. Current transformers
 - k. Potential transformers
 - l. Circuit breakers and/or motor circuit protectors
 - m. Fuses
 - n. Terminal blocks (power, control, and shorting)

- o. Surge protective devices
4. Layout drawings of the VFD that include:
- a. All cabinet or enclosure dimensions, access details, and weights.
 - b. Required clearances around the enclosure, e.g. ventilation.
 - c. Conduit entry areas and/or stub-up locations.
 - d. Nameplate sizes, colors, and locations.
 - e. Physical arrangement of door mounted devices located on the variable frequency drive enclosure.
 - f. Physical arrangement of **all** interior components, including DIN-rail-mounted devices.

General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

5. Custom schematic and interconnection wiring diagrams of all electrical work, including but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, terminal blocks and identification numbers, wire numbers, and other equipment comprising the complete system.
- a. These drawings shall be circuit specific for each motor-load combination (e.g. Disc Aerators, etc.). Specific equipment names consistent with the Drawings shall appear on each respective diagram.
 - b. Indicate all devices, regardless of their physical location, on the schematic diagrams.
 - c. Electrical ratings of all equipment and devices shall be clearly indicated on the schematic diagrams.

Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable.

6. Confirmation of spare parts requirements as specified herein.
7. Table listing all motor loads connected to the VFD. Table shall include the full load amps of the APPROVED motors. Final approval of VFD shop drawings cannot be given until all motor loads for each VFD have been reviewed, approved, and shown in this table.

- D. The shop drawing information shall be completed 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 catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

1.06 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, Section 01 30 00 – Submittal Procedures and Section 46 00 00 – Equipment General Provisions.
- B. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD. These final drawings be included in the O&M manuals and an additional copy that is plastic laminated and securely placed inside each VFD.
- C. The O&M manual shall include the "as-commissioned" parameters of each VFD in both print and digital formats.
- D. If the VFDs require computer software or configuration, the O&M manual shall include copies of all programming guides/manuals.

1.07 SPARE PARTS

- A. The VFDs and accessories 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:
 - 1. Two (2) sets of fuses for each size and type of fuse provided.
 - 2. One (1) HMI per type of HMI provided.
 - 3. One (1) set of enclosure air filters for each VFD.
 - 4. For each VFD unit **without** field-replaceable internals, furnish one (1) spare VFD unit per size provided.
 - 5. For each VFD unit **with** field-replaceable internals, furnish one (1) fully functional main control circuit board per VFD unit size provided.
- B. The 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.

- C. 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.
- D. Spare parts lists included with the shop drawing submittal 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.
- E. 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.

1.08 WARRANTY

- A. Contractor shall warrant that the material and workmanship of all components and the operation of the VFDs and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.
- B. Warranty shall include, but not be limited to the following:
 - 1. Replace components found to be faulty and make changes in equipment arrangement or make adjustments necessary to meet the equipment or functional requirements or this Specification.
 - 2. System rewiring and component substitution/rebuild.
 - 3. All accessories and appurtenances provided by the VFD manufacturer.
- C. Warranty shall be in effect for a period of 24 months following final acceptance of each VFD.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The equipment covered by this Specification is intended to be equipment of proven performance. 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 obtain the VFDs from one manufacturer who shall also manufacture and assemble the enclosure and major equipment components including, but not limited to the VFD unit and bypass starters. The manufacturer shall have five years minimum of experience in the manufacture of similar units and shall have a general distribution to the electrical trade. **Subcontracting of wiring and/or third-party assembly is not acceptable.**

- C. The VFDs shall be manufactured by the motor control center manufacturer as part of the mcc package.
- D. The VFD manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the appropriate sources and integrating these into a VFD that fulfills the requirements of this Specification.

2.02 VFD SYSTEMS

A. Operating Conditions

- 1. The following operating conditions are applicable for all equipment of this Specification.
 - a. Humidity: 0-95%.
 - b. Ambient Temperature: 0 degrees Celsius to plus 40 degrees Celsius.
 - c. Altitude: up to 3,300 feet

B. Basic Design and Performance

- 1. Each VFD shall be a complete alternating current electric drive system including all hardware and software necessary to accomplish variable speed operation of a motor and load combination. VFDs shall be provided in accordance with the requirements indicated on the Drawings and as described in these Specifications.
- 2. Each VFD shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete VFD system shall have a minimum short circuit current rating of 65,000 amperes symmetrical at rated voltage.
- 3. **The Contractor** is fully responsible for the review of the full Contract Documents to determine specified motor speed, horsepower and full load ampere requirements for each motor-driven load. In addition, the Contractor shall size and select the VFD and components as follows:
 - a. Each VFD shall provide, continuously, motor load current equal to 100% of the direct on-line motor nameplate full load current.
 - b. Each VFD shall be selected for Variable Torque (Normal Duty) unless otherwise stated.
 - c. The Load Type tables above are intended to exhaustively cover all possible equipment controlled by VFDs to be provided under Division 26 for this Contract. If a piece of equipment is found that is not explicitly listed in these

tables, this discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution **prior to submitting the Bid for this Contract.**

4. Each VFD shall be suitable to operate, at times, on a limited power source engine-generator set. The VFD shall be provided with equipment and devices to prevent waveform distortion as specified herein.
5. Each VFD shall be provided with control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks. Each VFD shall be designed such that specific control and protection functions can be attained through simple programming by either factory engineers or Owner's trained operating personnel. In addition, refer to Section 40 61 96 – Process Control Descriptions, for a description of the operation of each VFD.
6. Unless otherwise accepted in writing by the Engineer, VFDs shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals that exceed the ratings of the inverter duty rated motor winding insulation.

The Contractor is responsible for providing the VFD manufacturer with estimated and field-verified cable lengths between each VFD and its respective motor. The VFD manufacturer shall select and size the output reactors or filters based on the cable lengths provided by the Contractor. Any change in output filter or reactor selection and/or size from the Bid shall be immediately brought to the attention of the Engineer in writing for resolution.

The output filters or reactors shall be as manufactured by TCI, MTE Corporation, Mirus International, or engineer approved equal.

7. Motor control circuits shall be wired in accordance with the requirements specified herein and/or indicated on the Drawings.

C. Components

1. Each VFD shall contain the number of VFD units, as shown on the Drawings and required for the applications.
2. Each VFD shall contain the harmonic correction equipment as shown on the Drawings and required for the applications. Harmonic correction equipment shall be as specified elsewhere in this Specification.
3. Each VFD shall contain the number of auxiliary contacts, control power transformer(s), pilot devices and indicating lights, control relays, elapsed time meters, and other devices as specified herein, shown on the Drawings and

required for the applications. The following components shall meet the requirements of Section 26 09 16 – Electrical Controls and Relays:

- a. Pilot devices (switches, indicating lights, etc.)
 - b. Relays and timers
 - c. Terminal blocks
4. Each VFD shall be provided with full-capacity-rated contactors as shown on the Drawings and shall be electrically and mechanically interlocked as shown on the Drawings.
 5. Power terminal blocks for VFD output to the motor shall be fixed-mounted to a backplane or the enclosure. Mounting the terminal blocks on DIN rails is not acceptable.
 6. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.
 7. Each VFD shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.
 8. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100% redundant. New and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be provided in lieu of 100% redundant auxiliaries if accepted in writing by the Engineer.
 9. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished.
 10. Motor Circuit Protectors
 - a. Each VFD shall be protected by a motor circuit protector (MCP).
 - b. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction

must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

- c. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.
 - d. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.
 - e. Motor circuit protector ratings, modifications, etc., shall be as specified herein and as required for the VFD and motor load combination. MCP ratings shall be determined by the VFD manufacturer.
11. Where indicated on the Drawings, VFDs shall be provided with surge protective devices that meet the requirements of Section 26 43 13 – Surge Protection Devices.

D. Controls

- 1. Each VFD shall be provided with automatic and manual controls as shown on the Drawings and as required to comply with all Specifications. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings.
- 2. The Elementary Control Schematics shown on the Drawings are **representative of design intent only**. The manufacturer shall be responsible for providing all additional components, controls, and internal wiring necessary to meet the design intent.
- 3. VFD circuitry shall be designed such that the enclosure cooling fans only run when the VFD unit is producing output power. Designs that allow the enclosure cooling fans to run continuously when the VFD unit is energized but not producing output power are not acceptable. Fans that are used exclusively to provide cooling for the VFD unit (and not the overall enclosure) are permitted to run continuously if required by the VFD manufacturer's design standards/practices.

E. Enclosures

- 1. Equipment within the VFD enclosure shall be arranged so that it does not interfere with the entry of conduits and cables into the enclosure.

Unless otherwise indicated on the Drawings, VFDs in non-hazardous locations, 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
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. VFDs shall not be installed in hazardous locations.
3. NEMA 1 and NEMA 12 VFD enclosures shall be force ventilated with front accessibility and the following:
 - a. Enclosures shall be provided with washable enclosure air intake filters that can be replaced while the enclosure door remains closed.
 - b. Enclosures shall be designed for bottom or top entry of conduits and cables as required.
 - c. Enclosures shall be finished in ANSI-61 gray enamel or in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.
4. NEMA 4X VFD enclosures shall be air conditioned, dead-front, with front accessibility and the following:
 - a. The air conditioning system shall utilize a heat-exchange method that allows for cooling of the enclosure interior without circulating outside air through the enclosure.
 - b. Enclosures shall be furnished with tubular type enclosure space heaters. Space heaters shall be rated at 500V or 250V and operated at 240V or 120V, respectively.
 - c. VFDs shall be furnished with an additional control power transformer sized to provide power for the air conditioning system and enclosure space heater.
 - d. VFDs shall be furnished with a tamper-resistant hinged cover with a clear polycarbonate viewing window over the door-mounted pilot devices.

- e. VFDs shall be designed for bottom entry of cables only.
5. Each VFD shall be designed such that rear access to the enclosure is not required for operations, maintenance, or repair tasks.
 6. The Contractor shall reference the Drawings for maximum dimensions of the VFDs. The Engineer shall be notified prior to the initial shop drawing submittal if exceptions to the dimensions indicated on the Drawings are to be requested.
 7. Enclosure doors shall have full length piano type hinges and shall be braced to prevent sag when fully open.
 8. Each VFD enclosure shall be supplied with an industrial, heavy-duty flange-mount handle mechanism for the operation of the VFDs disconnecting means as follows:
 - a. The mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position.
 - b. The operator handle shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator.
 - c. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8-inch diameter shackle padlock.
 - d. The operator handle shall be mechanically interlocked such that the disconnecting means cannot be closed with the enclosure door open, nor can the enclosure door be opened when the disconnecting means is closed. A defeater mechanism shall be provided so that qualified personnel can bypass these interlocks for maintenance and testing purposes. The defeater mechanism shall allow the enclosure door to be opened without interrupting the operation of the VFD.

F. Nameplates and Legend Plates

1. Provide engraved plastic nameplates and legend plates to identify each VFD and associated door mounted devices and internal components. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.
2. Equipment names and/or numbers and device identification text shown on the Drawings shall be used as the basis to engrave the nameplates and legend plates. Where the equipment identification text would exceed the capacity of the VFD manufacturer's standard nameplate/legend plate size, the manufacturer shall provide larger nameplates and/or additional nameplates as necessary. Abbreviating equipment names/numbers and device identification text is not acceptable.

3. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked with identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

2.03 VFD UNITS

- A. The VFD unit shall be the Eaton SVX series, Square D Altivar 600 Series, Allen-Bradley PowerFlex 750 series, ABB ACS800 series, or Toshiba AS3 series.
- B. Basic Design and Performance
 1. Each VFD unit shall be of adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 VAC NEMA Design A or B induction motors. Units for other than NEMA Design A or B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.
 2. Each VFD unit shall consist of a semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the motor at the desired speed.
 3. Each VFD unit shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.
 4. The overall efficiency of each VFD unit shall be a minimum of 95% when operating the specified motor-load combination at rated voltage, frequency, and current.
 5. Each VFD unit shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed. The VFD unit shall be provided with adjustable maximum and minimum frequency limits.
 6. Each VFD unit shall maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5% of rated frequency of 60 Hertz for a 24-hour period and a repeatability of 0.1% of rated frequency of 60 Hertz.
 7. Each VFD unit shall be capable of operating the specified load continuously at any speed within the operating speed range of 10% to 100% of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable

within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

8. Each VFD unit shall be capable of controlled linear acceleration and deceleration. Each VFD unit shall be capable of ramping the speed of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Each VFD unit shall have two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.
9. Voltage or current unbalance between phases of the VFD unit output voltage shall not exceed 3% of the instantaneous values. The VFD unit shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3%. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.
10. Each VFD unit shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10% for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or overvoltage protection to trip and remove supply voltage from the drive system. VFD unit output voltage regulation shall be plus or minus 2%.

C. Features and Characteristics

1. Each VFD unit shall be furnished with a Human Machine Interface (HMI) to provide controls and indication to accomplish maintenance and operational functions as specified herein and shown on the Drawings. The HMI shall be password protected after startup to prevent unauthorized personnel from making changes. The HMI shall at minimum provide indication of the following:
 - a. Input Voltage
 - b. Output Voltage
 - c. Output Current
 - d. Output Frequency
 - e. Output Speed from 0-100%
 - f. Alarm Read-out
2. Each VFD unit shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback and remote speed indication.

3. Each VFD unit shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed equal to or less than 0.1% of rated speed.
 - a. Where shown on the Drawings, VFD units shall also accept the input from speed potentiometer(s) for manual speed control. Each VFD unit shall be capable of automatically switching between the input command signals as shown on the Drawings.
4. When operating in the automatic mode, the VFD unit shall shut down during a power outage or sustained undervoltage event. A sustained undervoltage event is defined as voltage that is less 75% of nominal, for more than 0.5 seconds. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the VFD unit shall automatically restart and then ramp up to speed as required by the control system. Personnel shall not be required to reset the system manually after a shutdown caused by a power outage or sustained undervoltage event.
5. Each VFD unit shall have a multiple attempt restart feature.
6. Each VFD unit shall have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The VFD unit shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.
7. Each VFD unit shall be furnished with programmable electronic overload and torque limits.
8. Each VFD unit shall have an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall lock-out the VFD unit and indicate the fault only upon the following conditions:
 - a. Output voltage unbalance (trip threshold field set).
 - b. Open phase.
 - c. Motor overload.
 - d. Motor stator winding fault (phase-to-ground, phase-to-phase).
 - e. Unacceptable voltage variation.
 - f. High variable frequency drive equipment temperature.

- g. VFD failure as determined by the manufacturer.
 - h. Component failure.
 - i. Overcurrent.
9. Provide each VFD unit with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the VFD unit as standard, this feature shall be capable of being disabled.
10. Each VFD unit shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure which in turn affects motor operation and generates an alarm contact output rated for 125 VDC suitable for interfacing with the control system.
- a. Diagnostics shall operate a visual alarm indicator that is visible on the variable frequency drive equipment cabinets without opening the cabinet doors.
 - b. Diagnostics shall provide an easily readable output that can be used to isolate a failure.
 - c. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.
 - d. Provide a normally open dry contact for each alarm function to enable remote indication.
11. Each VFD unit shall communicate the following parameters to the plant control system via Ethernet/IP protocol. Provide any necessary hardware gateways to provide this communication capability. The following parameters, at a minimum, shall be communicated:
- a. Current (all phases)
 - b. Voltage (all phases)
 - c. KW, KVAR, KVA
 - d. Power Factor
12. Each VFD unit shall be provided with input/output (I/O) expansion cards as necessary to facilitate connection of all I/O specified herein and shown on the Drawings.

2.04 HARMONIC CORRECTION

- A. Harmonic correction devices for each VFD shall be as specified herein and located as shown on the Drawings.
- B. Input Line Reactors
 - 1. 6-pulse VFD units shall be provided with input line reactor and/or integral DC link reactor. Total reactor impedance shall be a minimum of 3% and shall not exceed 5%.
- C. Passive Filters
 - 1. Where indicated on the Drawings or where additional harmonic correction is required, 6-pulse VFD units shall be provided with a passive harmonic filter in addition to the integral DC link reactor specified above (if present.)
 - 2. Passive harmonic filters shall be sized to attenuate harmonics resulting from operation of the VFD-driven motor load to no more than 5% THID when operating at full load, and no more than 8% THID when operating at 30% of full load. The filter shall be equipped with power contactors configured to remove the capacitors from the circuit when the VFD-driven loads are not in operation. The harmonic filters shall be as manufactured by TCI, MTE Corporation, Mirus International, or Engineer approved equal.
 - 3. Passive filters shall be integrated into the VFD unless accepted in writing by the Engineer or shown as separately mounted from the VFD on the Drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.
- B. Install VFDs to allow complete door swing required for component removal.

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. Certified Shop Tests and Reports

- a. Submit description of proposed testing methods, procedures, and apparatus.
 - b. Factory test the complete VFD in accordance with IEEE and NEMA standards.
 - c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.
3. 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 referenced in Section 26 05 00 – Basic Electrical Requirements.
 - b. The Contractor shall field measure actual harmonic distortion with tests performed by an independent testing agency acceptable to the Owner after satisfactory full-load operation. The Contractor shall provide the harmonic distortion reports with the O&M Manual.
 - c. Unless otherwise indicated on the Drawings, the harmonic distortion measurements shall be made at each load center where VFDs are present.
 - d. Harmonic distortion measurements shall be made after VFD installation. One set of measurements shall be made with the VFD loads inactive, and one set of measurements shall be made with the VFD loads running at design capacity.
- B. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.
 - C. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.
 - D. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

3.03 SERVICES OF A MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's

recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

- B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.
- C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (1) sessions of four (4) hours each. Training shall not take place until after the VFDs have been installed and tested. Training shall be conducted at times coordinated with the Owner.
- D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:
 - 1. One (1) trip of one (1) working day during installation of the motor controllers.
 - 2. One (1) trip of one (1) working day to perform startup and field acceptance testing of the motor controllers.
 - 3. One (1) trip of one (1) working day to perform training as specified herein.
 - 4. One (1) trip of one (1) working day two (2) months before the expiration of the warranty to identify any issues to be corrected under warranty.
- E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

3.04 PAINTING

- A. 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 coating as used for factory finishing coats.

END OF SECTION

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SECTION 26 43 13
SURGE PROTECTIVE DEVICES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and place in satisfactory operation, the surge protective devices (SPD) as specified herein and indicated on the Drawings.
- B. Reference Section 26 05 19 – Low-Voltage Conductors and Cables, and Section 26 05 53 – Identification for Electrical Systems.

1.02 CODES AND STANDARDS

- A. The surge protective device shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. Underwriters Laboratories, Inc. (UL)
 - a. UL1449, latest edition: Surge Protective Devices
 - b. UL1283, latest edition: Electromagnetic Interference Filters
- B. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE)
 - 1. C62.41.1: 2002 Guide for Surge Voltages in Low-Voltage AC Power Circuits
 - 2. C62.41.2: 2002 Recommend Practice on Characterization of Surges in Low Voltage (100V and Less) AC Power Circuits.
 - 3. C62.45: 2002 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
 - 4. C62.62: 2000 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in 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

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 re-submittal.
- C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.
- D. Shop drawings for each SPD shall include but not be limited to:
 1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E 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 this Specification Section. 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 this Specification Section.
 2. Product Data Sheets.
 3. Detailed drawings showing weights and dimensions.
 4. Wiring diagrams showing field connections.
 5. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL1449, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.
 6. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal

Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.

7. Proof that all products provided under this Section are UL listed and labeled by Underwriters Laboratories to UL 1283, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc) will be considered acceptable.

8. Manufacturer's Warranty Information

- 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 to provide are acceptable and shall be submitted.

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 by the Contractor to the Owner.
- B. The Contractor shall furnish one (1) spare field replacement module of each rating provided under this Contract.
- C. The 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.
- D. 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.
- E. Spare parts lists, included with the shop drawing submittal 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.
- F. 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 part number.

1.07 IDENTIFICATION

- A. Each SPD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each SPD. Nameplates shall be as specified in Section 26 05 53 – Identification for Electrical Systems.

1.08 WARRANTY

- A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.
- B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the warranty period, shall be replaced by the manufacturer at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The SPD units shall be UL 1449 Listed and must bear the UL mark. Units that are “manufactured in accordance with” UL 1449 or tested by other testing agencies “in accordance with” UL 1449 are not acceptable and will be rejected.
- B. Type II SPD units shall be UL 1283 Listed and must bear the UL mark. Units that are “manufactured in accordance with” UL 1283 or tested by other testing agencies “in accordance with” UL 1283 are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.

2.02 PRODUCTS

- A. Type I surge protective devices (SPD) shall be furnished and installed when shown without upstream overcurrent protection on the Drawings. Type II SPDs shall be provided in all other locations. Type II SPDs shall not require the use of a specific upstream overcurrent device. SPDs shall be provided in the location and quantity as shown on the Drawings.
- B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.
- C. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

- D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.
- E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

System Configuration	Modes of Protection	Number of Modes
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

- F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.
- G. The Nominal Discharge Current (In) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.
- H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1200V	800V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1800V	1800V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	800V	800V	1200V	800V

- I. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.
- J. SPDs which are indicated to be installed externally mounted from the equipment that they protect shall be provided within a separate enclosure. The enclosure shall match or exceed the NEMA rating of the enclosure for the equipment that it is serving (i.e. NEMA1, NEMA 12, NEMA 4X, etc).
- K. Each SPD shall be provided with the following accessories:

1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.
 2. Surge counter and audible alarm with reset/silence switch.
 3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.
- L. SPDs which are indicated to be installed integral within the equipment that they protect shall be fabricated by the same manufacturer as the equipment that they serve. SPDs which are indicated to be installed externally mounted from the equipment that they serve shall be manufactured by Eaton, ASCO/Emerson Network Power, Current Technologies, General Electric, or Square D.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The SPD units shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions
- B. SPDs which are indicated to be integral with the equipment that they protect shall be installed within the enclosure for that equipment.
- C. Prior to energizing, the following shall be performed for each SPD:
 1. Verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.
 2. Verify that any Neutral to Ground bonding jumpers are installed as required.

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. Shop Tests
 - a. Standard factory tests shall be performed on the equipment under this Section. All tests shall be in accordance with the latest version of NEMA, ANSI, and UL standards.
 - b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.

2. Field Tests
 - a. None required.

END OF SECTION

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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. Lighting shall be in accordance with the latest requirements of the Illuminating Engineering Society.
- C. Reference Section 26 05 00 – Basic Electrical Requirements and Section 26 05 26 – Grounding and Bonding for Electrical Systems.

1.02 CODES AND STANDARDS

- A. The equipment specified herein shall comply with the following codes and standards, where applicable.
 - 1. Underwriter’s Laboratories, Inc. (UL):
 - a. UL 924 – Emergency Lighting and Power Equipment
 - b. UL 935 – Fluorescent Lamp Ballasts
 - c. UL 844 – Luminaires for Use in Hazardous (Classified) Locations
 - d. UL 916 – Standard for Energy Management Equipment
 - e. UL 1029 – High Intensity Discharge Lamp Ballasts
 - f. UL 1598 – Luminaires
 - 2. American National Standards Institute (ANSI):
 - a. ANSI C82.11 – High Frequency Fluorescent Lamp Ballasts
 - b. ANSI C62.41 – Guide for Surge Voltages in Low-Voltage AC Power Circuits
 - 3. National Electrical Code (NEC), latest edition.
- B. Where equipment herein is specified as being Listed to a particular UL standard, that equipment shall be tested for compliance with the UL standard by either UL itself,

Factory Mutual (FM), or the Canadian Standards Association (CSA). Testing to UL standards by any other testing agencies is not acceptable.

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. Custom wiring diagrams for each individual lighting contactor application. Standard wiring diagrams that are not custom created by the manufacturer for the individual

lighting contactors for this project are not acceptable. One wiring diagram which is typical for all lighting contactors is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

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. The 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.
- C. 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.
- D. Spare parts lists, included with the shop drawing submittal, 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.

- E. 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.

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 for LED fixtures 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.

2.02 FIXTURES

- A. All lighting fixtures shall be furnished complete w 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 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 fixture schedule below.

Fixture Type	Lamp/Fixture Wattage	Description	Mfr. and Model
LP1	62W (max)	Pendant-mounted, 120-277VAC, LED light fixture, color temperature of 4000K, lineal ribbed frosted polycarbonate lens, wide distribution, gasketed frosted polycarbonate housing, stainless steel latches, 4ft, 4000 lumen minimum, and wet location Listed.	Holophane EVT4 LED Series, or Engineer approved equal.

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 Advance, Universal or equal.
- H. Drivers shall be UL Listed for damp location, UL1012, UL935, 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).

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, lamps, ballasts, 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, and lamps.
- 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 and/or lamps, as directed.
- L. No special tools shall be required for re-lamping of fixtures. 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.

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, 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 North Carolina Department of Transportation Standard Specifications for Roads and Structures. If there is a conflict between this specification and the Standard Specifications for Roads and Structures, the more conservative of the two shall take precedent.
- E. Erosion and Sediment Control shall be performed in accordance with Section 31 25 00 of these specifications and with the latest edition of the North Carolina Erosion and Sediment Control Planning and Design Manual (ESCPDM). 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 Materials Testing Consultant 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 (NOT USED)

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. North Carolina Department of Transportation Standard Specifications for Roads and Structures, latest edition.
2. North Carolina Department of Transportation Materials and Test Manual, latest edition.
3. American Society for Testing and Materials (ASTM):
 - a. ASTM C 127 – Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
 - b. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. ASTM D 698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³))
 - d. ASTM D 1140 – Standard Test Method for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
 - e. ASTM D 1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand Cone Method.
 - f. ASTM D 1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/lb³ (2,700 kN-m/m³)).
 - g. ASTM D 1883 – Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.
 - h. ASTM D 2216 – Test for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

- i. ASTM D 2487 – Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- j. ASTM D 4253 – Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- k. ASTM D 4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- l. ASTM D 6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- m. ASTM D 6938 – 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 NC811.com or 1-800-632-4949 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 NC811.com.

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. (Not used)
 - 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 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 NCDOT Standard Specifications for Roads and Structures.
- 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 NCDOT aggregates meeting the gradation requirements above may be used as Select Fill.
- F. Select Fill to be used as pavement subbase material shall be NCDOT Aggregate Base Course.
- G. Select Fill shall be placed in 10-inch-thick lifts, with the exception of NCDOT No. 57 aggregate, which may be placed in 12-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.
- B. Drainage Fill shall consist of NCDOT No. 57 aggregate.

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 health vegetation. It shall contain no substance potentially toxic to plant growth. All topsoil shall be tested by a recognized laboratory for the following criteria: Organic matter content shall not be less than 1.5% by weight. pH range shall be from 6.0 -7.5. If pH is less than 6.0, 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 500 ppm. If additional topsoil is needed, it must meet the standards stated above.

2.05 (NOT USED)

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. (Not used)
- C. 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.
- D. 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.

- E. 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.
- F. 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.
- G. 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.
- H. 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. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.
- I. 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.
- J. 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.

- K. 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. 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 contractor 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. 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 perform 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. All water removed by dewatering operations shall be disposed of in accordance with the North Carolina Sedimentation Pollution Control Act.
- C. 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 excavation area, at all times in order to maintain a dry and undisturbed condition.
- D. 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.
- E. 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.
- F. 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.
- G. 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.

- H. 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 embankment 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:

	Density % Standard Proctor (D 698)	Density % Mod. Proctor (D 1557)	Max. Lift Thickness as Compacted Inches
Embankments Beneath Structures and Roadways*	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 and Roadways	**	**	8
Crushed Stone Backfill	**	**	12
Crushed Stone Pipe Bedding	**	**	12
In Place Subgrade Beneath Structures	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.

B. Compaction Near Existing Structures

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. (Not Used)

C. (Not Used)

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.
- 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.

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 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 (NOT USED)

1.03 (NOT USED)

1.04 STANDARD SPECIFICATIONS

- A. Except as otherwise provided in the Specifications or on the plans, all work shall be in accordance with the North Carolina Department of Transportation Standard Specifications for Roads and Structures, 2002 except that any reference to "NCDOT", "Department" or "Unit" shall mean the "Owner". When reference to these Specifications is intended, the description will be NCDOT Section _____ or NCDOT Specifications.
- B. Except with the approval of the Engineer, the placing of concrete or asphalt concrete surface paving shall be subject to the Seasonal and Weather Restrictions set forth in NCDOT Specifications.

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 NCDOT Section 235, and Section 31 00 01 – Earthwork.

2.02 GRAVEL

- A. All work, including materials, associated with gravel shall be in accordance with NCDOT Section 545, Incidental Stone Base, except that Articles 545-6 and 545-7, shall be deleted.

2.03 AGGREGATE STABILIZATION

- A. All work, including materials, associated with Aggregate Stabilization shall be in accordance with NCDOT Section 510, Aggregate Stabilization, except that Articles 510-6 and 510-7, shall be deleted.

2.04 AGGREGATE BASE COURSE (ABC)

- A. All work, including materials, associated with Aggregate Base Course shall be in accordance with NCDOT Section 520, Aggregate Base Course, except that Articles 520-11 and 520-12 shall be deleted. Type "A" or "B" aggregate will be acceptable for this project.

2.05 ASPHALT BINDER FOR PLANT MIX

- A. All work, including materials, associated with asphalt binder shall be in accordance with Section 620, Asphalt Binder for Plant Mix, Grade PG 64-22, of the NCDOT Standard Specifications for Roads and Structures, except Articles 620-4 and 620-5 shall be deleted.

2.06 ASPHALT PAVEMENTS

- A. All work, including materials, associated with asphalt pavement shall be in accordance with Section 610, Asphalt Concrete Plant Mix Pavements, of the NCDOT Standard Specifications for Roads and Structures, except Articles 610-15 and 610-16 shall be deleted. Surface Course shall be Superpave S-9.5B, Intermediate Course shall be Superpave I-19.0B, and Base Course shall be Superpave B-25.0C. Asphalt pavement mix designs shall be in accordance with TABLE 610-2 of the NCDOT.
- 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 and NCDOT Section 700, General Requirements for Portland Cement Concrete Pavement and Section 710, Concrete Pavement, except that Articles 700-2, 700-15, 710-3, 710-4, 710-8, 710-9, 710-10, and 710-11 shall be deleted.

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 Section 605, Asphalt Tack Coat, of the NCDOT Standard Specifications for Roads and Structures, except that Article 605-10 shall be deleted.

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 in accordance with NCDOT Section 510-4. 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-19B for Intermediate) and be placed in lifts with a minimum thickness of 3-inches (2-inches for Intermediate) accordance with NCDOT Standard Specifications for Roads and Structures 610-8, Spreading and Finishing. Asphalt Concrete Base (or Intermediate) Course shall be compacted in accordance with NCDOT Standard Specifications for Roads and Structures 610-9, Compaction. 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. The asphalt tack coat shall be applied to the surface of the approved base/binder course as described in NCDOT Section 605. 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 at the rate of 110-pounds per square yard per inch. Surface Course shall be compacted in accordance with NCDOT Standard Specification for Roads and Structures, Article 610-9. Thicknesses shall be as shown on the Drawings.

3.06 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. Contraction joints shall be spaced at intervals as shown on the Drawings. Transverse contraction joints shall be formed by an approved joint insert. Expansion joints shall be placed when the pavement abuts a structure using 1-inch expansion joint material (filler) and sealant as specified herein.

3.07 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 25 feet. Formed control joints shall be installed at intervals not exceeding 10 feet. 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, 1/2" expansion joints and sealer shall be placed at a maximum spacing of 48-feet of sidewalk. 1/2" expansion joint material and sealer shall also be where sidewalks abut and rigid structure or curb and gutter.

3.08 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.

3.09 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.

3.10 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 NCDOT Section 605, Asphalt Tack Coat, of the NCDOT Standard Specifications for Roads and Structures, 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

SECTION 33 71 19
UNDERGROUND ELECTRICAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install underground duct systems, electric manholes, 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 Section 26 05 00 – Basic Electrical Requirements; Section 26 05 33.13 – Conduit for Electrical Systems; Section 26 05 26 – Grounding and Bonding for Electrical Systems; the applicable sections of Division 2, Sitework; Section 03 21 00 – Reinforcing Steel; and 03 30 00 – Cast-In-Place Concrete.

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 the manholes and/or handholes.
3. Materials specifications and structural calculations for the manholes sealed by a Professional Engineer licensed in the State or Commonwealth in which the project is located.

1.05 IDENTIFICATION

- A. Each electric manhole and handhole cover shall be lettered with the word "Electric", the manhole or handhole identification number (e.g. 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 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 equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. The underground duct system, manholes, 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 conduit 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.
- B. Concrete pours shall be complete from handhole to handhole and from manhole to manhole 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 manholes and 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. A minimum of one (1) ground rod, furnished in accordance with Section 26 05 26 – Grounding and Bonding for Electrical Systems, shall be driven adjacent to each manhole, handhole, or other concrete box. A No. 4/0 AWG bare copper ground cable shall be connected between this rod and the copper ground strap using a silicon bronze connector. All ground rods shall be interconnected by means of the No. 4/0 AWG bare copper ground cable located within each duct bank. The ends of these cables shall also be connected to substation and/or building ground buses where the conduits terminate.
- 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 manhole 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 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 MANHOLES

- A. Electric manholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 14" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to the roof. All manholes shall be built on or placed over a 6" layer of well-tamped gravel.
- 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 concrete work and fully assembled manholes shall be completely watertight and shall be furnished with sloped floors that pitch towards a sump pit. The outside surfaces shall be coated with an approved asphaltic waterproofing compound (all sides, bottom, and roof). Precast concrete manholes may be installed; however, all requirements of this Section and other Divisions of the Specifications and the details shown on the Drawings shall apply.
- D. Install pulling eye irons imbedded in walls opposite each duct entrance securely fastened to manhole reinforcing rods. All hardware shall be hot-dipped galvanized steel. Copper bars shall be provided in the walls for grounding. No. 4/0 AWG bare copper cables shall be connected to these bars and all non-current carrying metal parts shall be grounded to these copper bars.
- E. All cables shall be well supported on walls by nonmetallic cable racks. The cable racks shall be heavy-duty type for medium and low voltage power cables and light duty type for control, signal, communications and similar small conductors. All racks shall be rigidly attached to the wall and equipped with adjustable rack arms.

3.04 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 built on or placed over a 6" layer of well-tamped gravel.
- 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 fully assembled handholes shall be completely watertight.
- D. 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.

3.05 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 (NOT USED)

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 – Submittals. In addition to the requirements of Section 01 33 00 – Submittals, 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. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09 90 00 – Painting.
- 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 304 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 low carbon steel, zinc galvanized 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. Exposed couplings shall be painted in accordance with Section 09 90 00 – Painting.
- 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. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 40 06 20 – Schedules.

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			•	•	•	•	•	•	•

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Aluminum	•	•		•	•	•	•	•	•
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. 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. 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 2.5 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

- A. All pipe and fitting connected to and forming a part of a potable water supply shall be disinfected in accordance with the procedures described in AWWA C 651. Disinfection shall also be in accordance with the requirements of the North Carolina Division of Environmental Health and the Owner.
- B. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or NCDEH and/or the Owner until the minimum residual chlorine content of 10 ppm 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 new sections of pipe 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. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

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. In the absence of a standard color designation system, the Engineer will establish a standard color designation for

each piping service category from color charts submitted by the Contractor in compliance with Section 09 90 00 – Painting.

B. (Not used)

END OF SECTION

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SECTION 40 05 19
DUCTILE IRON PIPE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- 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 (DIP) of the sizes shown or specified shall conform to ANSI A21.51 (AWWA C151), Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds. All ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) for thickness design and shall be supplied in 18 or 20 foot nominal lengths or as required to meet the requirements of the Drawings. Fittings and specials shall be cast iron or ductile iron, conforming to the requirements of ANSI A21.10 (AWWA C110) or ANSI A21.53 (AWWA C153).
- C. Minimum Class 53 pipe shall be used for flanged spools.
- D. Reference Section 40 05 00 – Basic Mechanical Requirements
- E. Reference Section 40 06 20 – Process Pipe, Valve, and Gate Schedules, for pressure rating requirements for specific applications.

PART 2 – PRODUCT

2.01 DUCTILE IRON PIPE AND FITTINGS

- A. All pipe and fittings, with the exception of glass lined pipe and sleeves, shall be cement mortar lined. Linings shall conform to American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Ductile Iron Pipe and Fittings, ANSI A21.4 (AWWA C104) and shall be standard thickness. The mortar lining shall be protected with the bituminous seal coat. All buried DIP and fittings shall have a bituminous coating on the exterior surfaces in accordance with ANSI A21.51 (AWWA C151). All exposed DIP and fittings shall have a shop applied prime coat in accordance with Section 09 90 00 – Painting.
- B. Glass-lined ductile iron pipe shall be furnished and installed where specified in the Exterior Piping System Schedule. The finished lining shall be from 0.008-inch to 0.012-inch thick, hardness of from 5 to 6 on the Mohs Scale, density of from 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. The lining shall be Ervite Type SG-14, as manufactured by the

Ervite Corporation, Erie, Pa., Ferroch MEH-32, by Water Works Supply & Mfg., Co., Marysville, CA, or equal.

- C. 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 1/8-inch back from the cut. Flanges and bolt holes on spool pieces shall be aligned prior to glassing 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.
- D. 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.
- E. Flanged joints and fittings shall have a minimum pressure rating of 250 psi with 125 lb. American Standard flanges. All flanges and fittings shall conform to the requirements of ANSI B16.1. Flanges shall be ductile iron and shall be of the threaded or screw on type. The face of the flanges shall be machined after installation of the flange to the pipe. No raised surface shall be allowed on flanges. Flanged pipe shall conform to the requirements of ANSI Specification A21.15, (AWWA C115). Pipe lengths shall be fabricated to meet the requirements of the Drawings.
- F. Gaskets shall be the "Ring Gasket" type, 1/8-inch minimum thickness, cloth inserted rubber, red rubber or neoprene and shall be suitable for the service intended. Gaskets for glass lined pipe shall be TORUSEAL flange gasket, or equal. 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. The bolts for flanged joints shall be a minimum ASTM A307; Grade B carbon steel and be in accordance with ANSI A21.10, (AWWA C110). The bolts shall have hexagonal heads and nuts, no washers shall be used.
- G. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11 (AWWA C111). Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have cast-on lugs for adequately tying it together.
- H. Mechanical joints and fittings shall conform to the requirements of ANSI A21.11, (AWWA C111). 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 cast-on 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.
- I. Bolts for mechanical joints shall be high strength corrosion resistant low-alloy steel tee-head bolts with hexagonal nuts.

- J. 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. Gaskets shall be of rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated. 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. Couplings shall be as manufactured by Victaulic Company of America Style 31, or equal.
- K. 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. 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.
- L. Restrained fittings for piping systems 16-inches in diameter and greater shall have factory restraint systems identical to the factory restrained joint pipe specified in Item K above. All fittings shall be minimum pressure Class 250 unless otherwise specified.
- M. 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. 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.
- N. 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.
- O. 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

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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 D 1785, D 1784 and F 441, "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 D 1784 and D 1785. Fittings shall conform to the following standard specifications:
 - 1. Socket Type: (Schedule 40); ASTM D 2466
 - 2. Socket Type: (Schedule 80); ASTM D 2467
- D. (Not used)
- E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.
- F. 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 2672. 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.
- G. 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 2677. 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.
- H. 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± 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 2672. 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.
- I. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.
 - J. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D 2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D 2235.
 - K. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D 3034 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 D 3212. 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.
 - L. 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 D 1785, D 1784 and F 441, "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 D 1784 and ASTM F 441. CPVC fittings shall be socket type conforming to ASTM F 439.
- D. Solvent cement for socket type joints shall conform to ASTM F 493 for CPVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

2.03 (NOT USED)

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

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 (NOT USED)

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. (Not used)
- C. 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.
- D. 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.
- E. 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.
- F. 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 resealed 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.
- G. 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.

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SECTION 40 05 57
VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Equipment shall be provided in accordance with the requirements of Section 46 00 00 – Equipment General Provisions and Section 40 05 00 – Basic Mechanical Requirements.
- B. Reference Section 40 06 20 – Process Pipe, Valve, and Gate Schedules for additional information on valves and operators/actuators.
- C. The electric valve actuators shall meet the signal requirements described in Section 40 61 23 – Signal Coordination, Section 40 61 93 – Process Control System Input/Output List, and Section 40 61 96 – Process Control Descriptions.
- D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.
- E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.
- F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

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. Shop Drawings
 - 2. O&M Manuals
 - 3. Certification that the force required to operate all valves is as specified herein.

1.03 (NOT USED)

PART 2 – PRODUCTS

2.01 GENERAL

- A. Electric actuators shall be provided where specified in the Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.
- B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.
- C. Quarter turn valves 8” and greater in size shall have geared operators. Gate valves 14” and greater in size shall have geared operators.
- D. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

2.02 MANUAL OPERATORS

- A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:
 - 1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes. Where the depth of the operating nut is more than 4 feet below finish grade, a valve operator extension shall be provided to bring the operating nut to within 18-24 inches of the surface.
 - 2. Exposed valves up to 6-inch shall be lever operated (except gate valves).
 - 3. Exposed valves 8-inches and larger shall be handwheel operated.
 - 4. Exposed gate valves shall be handwheel operated.
 - 5. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator unless otherwise indicated on the Drawings.
- B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.
- C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.
- D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the

valve is to be installed as shown in the Piping Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.

- E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24”.
- F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504-94.
- G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.
- H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

2.03 ELECTRIC VALVE ACTUATORS

- A. Electric Actuators shall be open/close service or modulating service as specified in the Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules.
 - 1. Electric actuators shall be electromechanical type 480 V open/close service or modulating service for valves as specified in the Valve Schedule in Section 15390 – Schedules, as specified in individual equipment specifications, and/or as shown on the Drawings. Open/close (non-modulating) valve actuators and modulating valve actuators shall be Limitorque L120, Rotork equivalent, “or-equal”.
 - 2. Other manufacturers may be evaluated for acceptance as “or-equal” in accordance with Instructions to Bidders; Article 11.
- B. Performance Requirements
 - 1. The actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.
 - 2. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuator’s maximum rated breakaway of torque.
 - 3. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves

24 inches and larger. Operating time shall not be less than 60 seconds for all modulating valves.

4. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F – 160 degrees F.
 5. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of 60 starts per hour without overheating.
 6. For modulating actuators, the gearing, motor and contactor shall be capable of 1200 starts per hour without overheating.
- C. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes. Actuators located in classified areas shall be suitable for use in Class 1, Division 1, Group D environments.
- D. The actuators shall be provided with externally operable and lockable 480VAC circuit breakers integral to the control housing
- E. All gearing shall be hardened alloy steel or bronze and shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor without failure. Output drive gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. The worm gear pinion shall be alloy bronze. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Motor reduction gearing shall be spur or planetary gearing and shall allow for field repair and change in gear ratio. For quarter turn applications, overtravel of the operator shall be prevented by internal mechanical stops cast into the actuator.
- F. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.
- G. A handwheel shall be permanently attached for manual operation. A gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 40 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for handwheel operation, it shall return automatically to electric

operation when actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.

- H. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia. Motors shall be 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. Motors shall be totally enclosed, non-ventilated, with NEMA Class F insulation minimum (Class H for modulating actuators) and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor compartment. The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have plug and socket electrical connection to facilitate easy removal and replacement. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. The motor shall be capable of starting against the rated load in either the open or close direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.
1. Open/Close actuators shall be furnished with electro-mechanical reversing starters.
 2. Modulating actuators shall be furnished with solid state reversing starters utilizing thyristors.
- I. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting in from condensation. The following items shall be located in the control circuit compartment.
1. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.
 2. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step" with the

actuator output drive at all times in either the electrical or manual mode of operation. A minimum of six (6) contacts, three (3) normally open and three (3) normally closed, shall be supplied at each end of valve travel. Four (4) additional contacts shall be provided to report end of travel or any desired position between ends of travel.

- J. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20mADC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Division 40.
 - 1. Modulating valve actuators designed to respond to a 4-20mADC signal shall be provided with a valve positioner which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the "open," "closed," or "last" position on loss of 4-20 mADC command signal.
 - 2. Modulating valve actuators designed to respond to "pulse" open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to "pulse" open/close signals shall have the latching circuitry described above for open/close actuators disabled.
- K. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. The actuators shall be designed to operate from a single 480VAC, 3-phase source. The actuators shall be furnished with fuses inside of the terminal compartment. A quantity of two – ¾ inch NPT conduit entries shall be furnished.
- L. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.
 - 1. Open, Close, and Stop commands from external dry contacts (utilizing internal 120VAC power supply) and/or from an external signal of 12V to 120V. The inputs for the open, close, stop signals shall be field selectable to be respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.
 - 2. Emergency override input from a normally closed or normally open contact. The actuator shall either open or close (field selectable) upon receiving the emergency override input.

3. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.
4. Four (4) unpowered contacts shall be provided which can be selected to indicate valve "Opened" and "Closed" position, "Remote" status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.
5. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

M. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. L-O-R switch shall be padlockable in any of the three positions.
 - a. When the LOR is in the "Local" position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.
 - b. When the LOR is in the "Off" position, the actuator shall not operate.
 - c. When the LOR is in the "Remote" position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.
2. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

N. Remote Manual Control Station

1. Where indicated in the Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules, manual actuator controls shall be furnished in a separate NEMA 4X stainless steel enclosure (NEMA 7 if located in a classified area). Manual control station controls shall include Hand–Off-Auto Selector switch; Open, Stop, and Close pushbuttons; a red lamp indicating closed and a green lamp indicating open.
 - a. When the HOA is in the "Hand" position, open/close control shall be by the open and close pushbuttons on the remote manual control station. The stop push button shall stop actuator travel.
 - b. When the HOA is in the "Off" position, the actuator shall not operate.

- c. When the HOA is in the “Auto” position, the actuator shall be controlled by remote inputs to the valve actuator from the PLC.

2.04 ELECTRIC OPERATORS FOR PVC/CPVC VALVES

- A. Automatic electric operators shall be provided for PVC/CPVC valves where specified and/or as shown on the Drawings. Operators shall operate on 120VAC, single phase, 60 hertz power and be equipped with internal electric controls. Motors shall be brushless, capacitor-run, reversing type, suitable for high duty cycle applications and shall be specifically designed for open/close service. Motors shall be provided with integral thermal overload protection with auto-reset. Operator shall have a receiving socket to mount to the ball valve shaft. Operator gear trains shall be permanently lubricated. The gear train shall withstand operator stall torque. Operator enclosures shall be NEMA 4X and IP67 rated. Operators shall be provided with internally wired, thermostatically controlled enclosure heaters to maintain an enclosure temperature of at least 40 degrees F. Operators shall be provided with positive visual position indication markings permanently affixed to the operator body and final output receiver. Operator drive output shall be provided with a declutchable manual override. A hand wheel shall be provided for manual valve positioning.

- B. Independently adjustable cam-operated position limit switches shall be provided with dry contacts for remote fully opened and fully closed valve position indication. Operators shall respond to external 120VAC powered open/close control signals. All actuator control circuitry shall be internal to the valve actuator. Valve control circuits and components mounted in a separate enclosure external to the valve actuator assembly will not be permitted. Limit switches shall be Form A rated for 3 amps at 250VAC. The Contractor shall coordinate operator controls with the functional requirements specified in Section 40 61 96 – Process Control Descriptions.

- C. Electric operators for PVC/CPVC valves shall be Hayward HRSN2 Series, or approved equal.

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 for electric actuators:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.02 INSTALLATION

- A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable Specification Sections for valves and motor controls.
- B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

3.03 SHOP TESTING

- A. Shop testing shall be in accordance with Section 46 00 00 – Equipment General Provisions and with the following additional requirements:
 - 1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.
 - 2. Submit written certification that:
 - a. Shop tests for the electrical system and all controls were successfully conducted;
 - b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.
 - 3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:
 - a. Current at maximum torque setting
 - b. Torque at maximum torque setting
 - c. Flash Test Voltage
 - d. Actuator Output Speed or Operating Time
 - e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.
 - f. Verification of actuator torque rating with valve.

3.04 FIELD TESTS

- A. Field testing shall be in accordance with Section 46 00 00 – Equipment General Provisions and with the following additional requirements:

1. Valve actuators shall be field-tested together with the associated valves.
2. Test all valves at the operating pressures at which the particular line will be used.
3. Test all valves for control operation as directed.
4. Field testing shall include optimization of opening and closing times of the valves. 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.

B. Preliminary Field Tests

1. General: 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.
2. Scope: 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.
3. 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, as specified or otherwise directed.

C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.
2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.
3. Final 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.
4. Certification of Equipment Compliance: After the final field tests are completed and passed, submit affidavit according to Section 46 00 00 – Equipment and General Provisions.

END OF SECTION

SECTION 40 05 62

PLUG VALVES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.

PART 2 – PRODUCTS

2.01 PLUG VALVES

- A. Plug valves shall be of the non-lubricated, eccentric seating plug type with synthetic rubber-faced plugs conforming to the latest revision of AWWA 517 as manufactured by DeZurik Company, Pratt, Milliken, GA Industries or equal. All valves shall be provided with limit stops and rotate 90 degrees from fully open to fully shut. The minimum working pressure for all valves shall be 150 psi, and the test pressure shall be at least 270 psi for valves up through 12-inch and at least 230 psi for valves 14-inch and larger. The port area of valves shall be 100 percent of full pipe area (i.e. “full port”) for valves less than 24-inches and 70 percent for valves 24-inches and larger, unless otherwise specified herein or indicated in the appropriate Valve Schedule in Section 40 06 20 – Process Pipe, Valve, and Gate Schedules. The body materials shall be of epoxy coated cast iron or ductile iron, unless specified otherwise. Seats shall have a welded overlay of at least 90 percent pure nickel and machined to a finish containing no stress cracks. Plug facings shall be of Buna-N or equal and completely suitable for use with domestic sewage.
- B. 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. Plug valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator.
- C. All buried valves shall have mechanical joint ends (unless otherwise shown), conforming to ANSI A21.11 (AWWA C111), and shall be operated with a standard AWWA 2-inch square nut through a totally enclosed worm gear actuator. Valve boxes shall be installed with all buried plug valves and shall be as specified herein.
- D. Unless otherwise shown, all exposed valves 4-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard with face-to-face dimensions of standard plug valves. Valves smaller than 4-inches in diameter shall have screwed ends, unless otherwise noted.

- E. Valves 8-inches in diameter and larger shall be handwheel or floorstand operated where required or indicated on the Drawings through totally enclosed worm gear actuators, unless otherwise specified or shown on the Drawings. Valves 6-inches in diameter and smaller shall have lever operators, unless otherwise specified or noted on the Drawings. Manual operators for plug valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators.
- F. The manufacturer shall certify that the plug valves are capable of operating in continuous duty service under these pressures and flow conditions.
- G. 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.
- H. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel, nickel, 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.

END OF SECTION

SECTION 40 05 63

BALL VALVES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.
- B. Valves required for chemical service shall be constructed of materials suitable for the intended service.

PART 2 – PRODUCTS

2.01 BALL VALVES (WATER SERVICE)

- A. Ball valves (water service) shall be of the full port, single seated, metal to metal seated, tight-closing type conforming to the latest revision of AWWA C507 Specifications. The manufacturer shall have a minimum of 5 years of experience in manufacturing ball valves of the sizes required in accordance with AWWA C507 Specifications. All ball valves shall be the product of one manufacturer. Ball valves shall be as manufactured by Willamette Valve, Inc., or equal.
- B. Each valve shall be performance and leak tested as specified in AWWA C507 revised as follows: In addition to the testing requirements of AWWA C507, each ball 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.
- C. Ball valves shall be AWWA Class 150, unless otherwise indicated in the valve schedules, design with flanged ends, and installed as shown on the Drawings.
- D. The valve body shall be constructed of epoxy coated cast iron conforming to ASTM A 48, Class 35, with a full, unrestricted circular inlet and outlet, with nominal opening diameter equal to the rated size of the valve. Each valve body shall be provided with flanged ends conforming in diameter and drilling to ANSI B16.1, Class 125. All flanges shall be flat faced and finished to true plan surfaces within a tolerance limit of 0.005 inch. Each flange face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Flange faces shall have concentric or spiral serrated finish. The body trunnions shall be fitted with ample sized bronze bearings of sufficient difference in hardness from the plug bearings to eliminate seizing and galling. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing teflon coated or other

non-metallic material will not be acceptable. Bearings shall be machined in accurate alignment for reception of the plug trunnions.

- E. The body shall provide rigid means for supporting the valve operating mechanism without the necessity of additional supports and shall be of such design that it shall be capable of receiving the complete plug sub assembly. The valve body shall have integral hubs for housing shaft bearings and seals.
- F. The body shall have a rigidly attached metal seat. The body seat shall be Monel (Alloy 400) and shall be machined, ground and polished for contact with the stainless steel seat mounted on the plug.
- G. There shall be two (2) pipe connections, one for an air vent and the other for drain.
- H. The plug shall be constructed of epoxy coated cast iron conforming to ASTM A48, Class 35, with a full unobstructed, circular waterway with a diameter equal to the rated size of the valve. It shall have trunnion supports cast integral on the axis of rotation. An extension of one trunnion, called the operating shaft, shall pass through a shaft seal chamber and connect to the valve operation mechanism.
- I. The plug shall have a stainless steel seat conforming to ASTM A276, Type 304, mounted thereon which shall properly align with the body seat when the valve is in the closed position. The surfaces of the seat ring shall be spherically generated and shall be machined, ground and polished for contact with the body seat.
- J. The plug trunnions shall be fitted with bronze bearings of sufficient difference in hardness from the body bushings to eliminate seizing and galling.
- K. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing Teflon coated or other non-metallic bearing material will not be acceptable.
- L. Valve shafts shall be integral with the plug and shall connect the plug to the torque unit. The shaft shall be of chrome Molybdenum Steel (ASTM A 322 Grade 4140) with hard chrome plate through the seal chamber 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 plug 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.
- M. 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 heavy-duty bronze. The valve assembly shall be furnished with a factory set thrust bearing designed to center the valve plug in the valve seat at all times. End cover bolts shall be of stainless steel construction.

- N. A shaft seal shall be provided of the type utilizing a plug shaft stuffing box, four (4) "O" ring seals, a bronze retainer and a corrosion resistant steel lock ring. The "O" ring material shall be BUNA-N rubber, as intended for use with potable water or wastewater.
- O. Manual operators for ball valves 18-inches in diameter or larger shall be the worm gear or travelling nut type conforming to AWWA C507. Manual operators for ball 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 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. Electric motor operators shall be as specified elsewhere in this Section.
- P. The torque unit (valve operating mechanism) shall be of the traveling-nut type and shall be the product of the valve manufacturer. The assembly shall be mounted and attached to the valve body. The torque unit shall be designed to accept a manual, cylinder or electric motor actuator. The torque unit housing shall employ the following:
1. A traveling crosshead to impart positive rotary movement to the plug which will move transversely to the valve shaft.
 2. A cylinder piston rod or stainless steel Type 416 threaded leadscrew (reach rod or stem) with the crosshead directly attached thereto.
 3. A rotator lever (of cast steel construction).
 4. A matched set of interconnecting links (of cast steel construction) connecting the traveling crosshead to the rotator lever.
- Q. The traveling crosshead shall be confined to permit linear motion only and to prevent it from any tendency to rotate due to linkage reaction. A plug shaft support bearing shall be supplied on the cover.
- R. The torque unit shall be so designed that during the first 50 percent of stroke in closing the flow area is reduced by approximately 81 percent. The remaining 19 percent of flow area shall be gradually reduced to a complete shutoff throughout the last 50 percent of the closing stroke.
- S. The torque unit shall be totally enclosed in a suitable housing with a removable cover and shall be capable of being inspected, lubricated, adjusted and repaired without interfering with or removing the valve from the line and shall be permanently lubricated. All parts shall be of first class workmanship, easily replaceable and manufactured of the best materials suited for the purpose. All parts subject to rubbing shall be of significantly different hardness to prevent galling and shall be sized to result in a maximum bearing stress at full load of 2,000 psi. The main shaft shall be replaceable without removing the torque unit housing and while the valve is in the line under pressure.

- T. The manufacturer shall certify that the ball valves are capable of operating in continuous duty service under these pressures and flow conditions.
- U. 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.
- V. 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.

2.02 (NOT USED)

2.03 (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 05 65.23
CHECK VALVES

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Reference Section 40 05 00 – Basic Mechanical Requirements.
- B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

PART 2 – PRODUCTS

2.01 SWING CHECK VALVES (WATER SERVICE)

- A. Unless otherwise specified, check valves 3-inches and less shall be bronze, Y-pattern, swing check valves of the regrinding type. Valves shall have a minimum 200 psi non-shock cold water pressure rating and shall be as manufactured by Jenkins Bros. Corp., Crane Company, or equal.
- B. Check valves larger than 3-inches shall be cushioned swing check valves rated for a minimum working pressure of 200 psi and shall be of the "Shockless Swing-Check" type as manufactured by G.A. Industries, or equal.
- C. Valve closure shall be controlled by an external weighted lever arm, the action of which is cushioned by a hydraulic oil or pneumatic cylinder. Counterweights and cushion cylinders shall be designed so that adjustments can be made in the field to minimize surge and to prevent backflow and hammering noises during actual service conditions. The hydraulic oil or pneumatic cushion system shall be completely self-contained.
- D. Valve bodies, cover discs, levers, and disc arms shall be constructed of heavy cast iron or cast steel fully conforming to the latest revision of ASTM A-126 Class B or Class WCB, respectively. Valve ends shall be Standard American 125 pound flat-faced flanged, in accordance with ANSI B16.1. Each valve disc shall be suspended from a noncorrosive shaft which shall pass through a stuffing box and be connected on the outside of the valve to the cushion and counterweight mechanism.
- E. Valve seating shall be rubber-to-metal designed for drop-tight shutoff. The body seat ring shall be made of bronze or stainless steel and the disc seat ring of 80 Durometer rubber. Body and disc seats shall be renewable.
- F. With the exception of the valve body and seat, all parts in contact with water shall be manufactured from noncorrosive materials. Internal corrosive surfaces shall be shop

Painted with two coats of epoxy for corrosion resistance. Exterior surfaces shall be painted in accordance with the requirements of Section 09 90 00 – Painting.

2.02 (NOT USED)

2.03 (NOT USED)

2.04 (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. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09 90 00 – Painting.
- 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. Colors shall be as directed by Owner for each specific service.

END OF SECTION

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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WASTEWATER 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
W	WATER	< 4" PVC / CPVC ³	SOCKET	SCH 80	SOCKET/ FLANGED	SCH 80	YES	150	150	225	225
		> = 4" DIP	RESTRAINED	PRESSURE CLASS 51	FLANGED	CLASS 53	NO				
SC	SCUM	DIP (GLASS LINED)	RESTRAINED	PRESSURE CLASS 51	FLANGED	CLASS 53	NO	50	50	75	75
SL	SLUDGE	DIP	RESTRAINED	PRESSURE CLASS 51	FLANGED	CLASS 53	NO	50	50	75	75
		PCCP	RESTRAINED	SECTION 33 05 39.13	N/A	N/A	N/A				

1) Restraint system design pressure shall be equal to the sum of working pressure and surge pressure and shall be used to determine the size, number, material, and dimensions of tabs and threaded-rods for piping specified or shown to have threaded-rods for thrust restraint.

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.

ELECTRICALLY OPERATED VALVE SCHEDULE

TAG NO.	VALVE TYPE	OPERATOR TYPE	SIZE (in.)	FLOW	MAX DIFFERENTIAL PRESSURE (psi)	CLASS	SERVICE	LOCATION
MOV-301	PLUG	OPEN/CLOSE	1	25 GPM	150	150	PW	CLARIFIER NO. 1
MOV-302	PLUG	OPEN/CLOSE	1	25 GPM	150	150	PW	CLARIFIER NO. 2
MOV-303	PLUG	OPEN/CLOSE	1	25 GPM	150	150	PW	CLARIFIER NO. 3
MOV-304	PLUG	OPEN/CLOSE	1	25 GPM	150	150	PW	CLARIFIER NO. 4
MOV-331	PLUG	MODULATING ¹	4	550 GPM	10	150	SLUDGE	SLUDGE FLOW CONTROL VAULT NO. 1
MOV-332	PLUG	MODULATING ¹	4	550 GPM	10	150	SLUDGE	SLUDGE FLOW CONTROL VAULT NO. 2
MOV-333	PLUG	MODULATING ¹	4	550 GPM	10	150	SLUDGE	SLUDGE FLOW CONTROL VAULT NO. 3
MOV-334	PLUG	MODULATING ¹	4	550 GPM	10	150	SLUDGE	SLUDGE FLOW CONTROL VAULT NO. 4

1) Pulse Control - See Specifications 40 05 57 and 40 61 96

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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, if heat tracing is included in project.
- 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 (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 61 13
PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 – GENERAL

1.01 SCOPE

- A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, components, system installation services, as well as required and specified ancillary services in connection with the Instrumentation, Control and Information System.
- B. The System includes materials, labor, tools, fees, charges, and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system.
- C. The system shall include measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, signal and data transmission systems, interconnecting wiring, and pertinent accessories.
- D. The scope of the work to be performed under this Division includes but is not limited to the following:
 - 1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
 - 2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
 - 3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Sections 40 61 13 through 40 79 00, inclusive and where included.
 - 4. Furnish and install digital control system hardware and software as specified in Sections 40 61 13 through 40 79 00, inclusive and where included.
 - 5. Final termination and testing of instrumentation and control system signal wiring and power supply wiring at equipment furnished under Sections 40 61 13 through 40 79 00, inclusive and where included.
 - 6. Furnish, install and terminate special cables for devices. Furnish and terminate control system communication network cables.

7. Furnish and install surge protection devices for digital equipment, local control panels, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 26.
 8. Coordinate grounding requirements with the electrical subcontractor for digital equipment, local control panels, and instrumentation provided under this Division. Terminate grounding system cables at equipment provided under this Division.
 9. Provide system testing, calibration, training and startup services as specified herein and as required to make systems fully operational.
- E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls, and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested, and calibrated as specified under other Divisions unless otherwise indicated.
- B. Additional and related work performed under Division 26 includes the following:
1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for equipment, control panels and accessories furnished under Sections 40 61 13 through 40 79 00, inclusive and where included.
 2. Conduit and raceways for instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.
 3. Instrumentation and control system signal wiring.
 4. Install control system communication network cables.
 5. Furnish and install grounding systems for digital equipment, local control panels, remote telemetry units, and instrumentation provided under Sections 40 61 13 through 40 79 00, inclusive and where included. Grounding systems shall be complete to the equipment provided under Sections 40 61 13 through 40 79 00, inclusive, and where included, ready for termination by the instrumentation subcontractor.
 6. Termination of instrumentation and control system signal wiring at equipment furnished under other Divisions of the Specifications.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g., panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.
- B. In order to centralize responsibility, it is required that equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating signals, and furnishing appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment/systems and shall provide for the services of a qualified installation engineer to supervise activities required to place the completed facility in stable operation under full digital control.
- D. The instrumentation and control system shall be capable of simultaneously implementing all real time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of other system components.
- E. Control system inputs and outputs are listed in Section 40 61 93 – Process Control System Input/Output List. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.
- F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect equipment, panels, instrumentation, controls, and appurtenances, either existing or furnished on the Project

to determine requirements for interfacing with the control and information system. The Contractor shall coordinate the completion of required modifications with the associated supplier of the item furnished.

- G. The instrumentation subcontractor shall review and approve the size and routing of instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.
- I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to observe materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records, and certifications during all stages of design, fabrication, and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies, and services required for these observation activities.
- K. The terms "Instrumentation," "Instrumentation and Control System," and "Instrumentation, Control and Information System" shall hereinafter be defined as equipment, labor, services, and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

- A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities, remote telemetry systems for water supply/distribution systems, and remote telemetry systems for wastewater collection systems. Instrumentation and control system subcontractors shall have a minimum of five years of such experience and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers/models of major hardware or software products (PLC, HMI software, network, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made.
- B. Acceptable instrumentation and control system subcontractors shall be CITI, RS Integrators, "or equal".

- C. Other subcontractors may be evaluated for acceptance as “or-equal” in accordance with Instructions to Bidders; Article 11.

1.05 DEFINITIONS

- A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.
- B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.
- C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
- D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.
- E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.
- F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (\text{MTBF} / (\text{MTBF} + \text{MTTR})) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1 - A1) * (1 - A1))$$

where:

A1 = availability of non-redundant device or system

A2 = availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

1. A - Availability
2. ADC - Analog to Digital Converter
3. AI - Analog Input
4. AO - Analog Output
5. AVAIL - Available
6. BCD - Binary Coded Decimal
7. CSMA/CD - Carrier Sense Multiple Access/Collision Detect
8. CPU - Central Processing Unit
9. CRC - Cyclic Redundancy Check
10. CS - Control Strategy
11. DAC - Digital to Analog Converter
12. DBMS - Data Base Management System
13. DI - Discrete Input
14. DMA - Direct Memory Access
15. DO - Discrete Output
16. DPDT - Double Pole, Double Throw
17. DVE - Digital to Video Electronics
18. EPROM - Erasable, Programmable Read Only Memory
19. FDM - Frequency Division Multiplexing
20. FSK - Frequency Shift Keyed
21. HMI - Human Machine Interface (Software)
22. I/O - Input/Output
23. LAN - Network and Communication Equipment
24. LCD - Liquid Crystal Display

25. LDFW - Lead Follow
26. MCC - Motor Control Center
27. MTBF - Mean Time Between Failures
28. MTTR - Mean Time to Repair
29. OS - Operating System
30. PAC - Programmable Automation Controller
31. PCB - Printed Circuit Board
32. PID - Proportional Integral and Derivative Control
33. PLC - Programmable Logic Controller or Programmable Controller
34. PROM - Programmable Read Only Memory
35. RAM - Random Access Memory
36. RDY - Ready
37. RMSS - Root Mean Square Summation
38. RNG - Running
39. ROM - Read Only Memory
40. RTU - Remote Telemetry Unit
41. SPDT - Single Pole, Double Throw
42. ST/SP - Start/Stop
43. TDM - Time Division Multiplexing
44. UPS - Uninterruptible Power Supply
45. VFD - Variable Frequency Drive

H. To minimize the number of characters in words used in textual descriptions on displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (e.g., dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SCHEDULE OF PAYMENT

- A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.
- B. Requests for payment for materials and equipment that are not installed on site but are required for system construction and the factory witness test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.
- C. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

3.02 CLEANING

- A. The Contractor shall thoroughly clean soiled surfaces of installed equipment and materials.
- B. Upon completion of the instrumentation and control work, the Contractor shall remove surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

- A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:
 - 1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.
 - 2. Completion of the Availability Demonstration.
 - 3. Completion of control system training requirements.
 - 4. Completion of punch-list items that are significant in the opinion of the Engineer.
- B. Final acceptance of the System shall mark the beginning of the warranty period.

END OF SECTION

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SECTION 40 61 15
PROCESS CONTROL SYSTEM SUBMITTALS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General and Supplemental Conditions and Division 01 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.
- B. All submittal materials shall be tailored to this project by highlighting relevant items or crossing out non-applicable items. Generic submittals without identified options will be returned the Contractor without review.
- C. Compliance, Deviations, and Exceptions (CD&E) Letter:
 - 1. Where a named manufacturer and product is specified and a substitution or an “or equal” product is submitted, the submittal shall be accompanied by a “Compliance, Deviations, and Exceptions (CD&E) letter.” If the required submittal is submitted without the letter, the submittal will be rejected.
 - 2. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor, subcontractor (if applicable), and the equipment Manufacturer/Supplier. This letter shall include a copy of the Specification Section to which the submittal pertains. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in.
 - a. The letter "C" shall be for full compliance with the requirement.
 - b. The letter "D" shall be for a deviation from the requirement.
 - c. The letter "E" shall be for taking exception to a requirement.
 - 3. 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 shall not be acceptable.
 - 4. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 – Submittal Procedures

- B. Section 40 61 13 – Process Control System General Provisions

1.03 EXISTING CONDITIONS / AS-BUILT DOCUMENTATION SUBMITTAL

- A. Prior to modifying, demolishing, removing, or decommissioning equipment, thoroughly investigate and document the existing conditions. Please note that Owner's record drawings alone are not sufficient for documentation. The record drawings, if present, shall be verified in the field prior to submitting. Submit drawings, markup, sketches, information, or other materials for documenting the following existing conditions:
 - 1. All I/O on PLC modules that have its wiring modified or new I/O terminated or for any PLC that is being decommissioned/removed/demolished. Document module number, point number, wire numbers, terminal numbers, destination, and function.
 - 2. All wiring entering or leaving a PLC that is being decommissioned, removed, or demolished that is not otherwise accounted for.
- B. When all information has been gathered, it shall be submitted to Engineer along with a clear and unequivocal statement that the existing conditions have been documented and understood. Contractor shall be held responsible for all issues that arise due to Contractor's modifications, demolition, removal, or decommissioning of existing equipment, including necessary reversion back to previous conditions.

1.04 DIGITAL HARDWARE SUBMITTALS

- A. Submit system block diagram(s) showing:
 - 1. All equipment to be provided.
 - 2. All interconnecting cable.
 - 3. Equipment names, manufacturer, and model numbers.
 - 4. Equipment locations.
- B. Submit information for all digital equipment including, but not limited to, the following:
 - 1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 - 2. Catalog cuts, including complete part number breakdown information.
 - 3. Complete technical, material and environmental specifications.
 - 4. Assembly drawings.
 - 5. Mounting requirements.

6. Color samples.
7. Nameplates.
8. Environmental requirements during storage and operation.

1.05 SOFTWARE SUBMITTALS

A. Software submittals shall include the following as a minimum:

1. Bill of materials with software names, vendors, and complete listings of included software modules.
2. Standard manufacturer's literature describing the products.
3. Description of function of software in Control and Information System.
4. Limitations or constraints of software.
5. Minimum system (processor and memory) requirements.
6. Operation and maintenance requirements.

B. Submit information on the following software:

1. Third-party software, including:
 - a. Operating system.
 - b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).
 - c. Office-type products, such as spreadsheets, word processors, etc.
 - d. Database management software.
 - e. Communication software, including all applicable local and wide area network software.
 - f. Programmable controller programming software (where applicable).
2. Software configuration, including:
 - a. Graphic display organization.
 - b. Database configuration for operator workstations and database management system.

- c. Trends.
- d. System security.
- e. Formats for all reports, including all required calculations.
- f. Intercommunications between software products required to implement system functions.
- g. Equipment backup configuration and requirements.

C. Control Strategies

- 1. Description of automatic logic and all non-standard manual logic using plain English, for non-technical persons, and written in Contractor's own words. The write-up shall include references to associated I/O, tag/loop numbers, alarming/interlocks.
- 2. Submitting language verbatim to Section 40 61 96 – Process Control Descriptions shall not be acceptable.

D. Application Software

- 1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- 2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

E. Graphic Displays

- 1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.
- 2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.
- 3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters and is intended to allow the Contractor to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.

4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.
5. The required submittals in each revision cycle shall be full color prints of the entire set of displays.
6. Displays shall be printouts of actual process graphics implemented in the system.

1.06 CONTROL PANEL SUBMITTALS

- A. Submittals shall be provided for all control panels, and shall include:
 1. Exterior panel drawings with front and side views, to scale.
 2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
 3. Panel area reserved for cable access and conduit entry.
 4. Location plans showing each panel in its assigned location.
- B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:
 1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 2. Catalog cuts, including complete part number breakdown information.
 3. Complete technical, material and environmental specifications.
 4. Assembly drawings.
 5. Mounting requirements.
 6. Color samples.
 7. Nameplates.
 8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.07 INSTRUMENT SUBMITTALS

- A. Submit information on all field instruments, including but not limited to the following:
 - 1. Product (item) name and tag number used herein and on the Contract Drawings.
 - 2. Catalog cuts, including complete part number breakdown information.
 - 3. Manufacturer's complete model number.
 - 4. Location of the device.
 - 5. Input output characteristics.
 - 6. Range, size, and graduations.
 - 7. Physical size with dimensions, NEMA enclosure classification, and mounting details.
 - 8. Materials of construction of all enclosures, wetted parts and major components.
 - 9. Instrument or control device sizing calculations where applicable.
 - 10. Certified calibration data on all flow metering devices.
 - 11. Environmental requirements during storage and operation.
 - 12. Associated surge protection devices.
 - 13. Installation drawings/details.

1.08 WIRING AND LOOP DIAGRAMS

- A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.
- B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.
- C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3.

- D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

1.09 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01 33 00 – Submittal Procedures. Operation and maintenance (O&M) manuals shall consist of two basic parts:
 - 1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
 - 2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.
 - 1. A comprehensive index.
 - 2. A functional description of the entire system, with references to drawings and instructions.
 - 3. A complete "as built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
 - 4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 - 5. Full specifications on each item.

6. Detailed service, maintenance, and operation instructions for each item supplied.
 7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
 8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
 9. References to manufacturers' standard literature where applicable.
 10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- D. The operating instructions shall clearly describe the step by step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.
- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
1. Operation Information: This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
 2. Preventive Maintenance Instructions: These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.
 3. Corrective Maintenance Instructions: These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
 4. Parts Information: This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.

- G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:
1. A program abstract that includes:
 - a. Program Name - The symbolic alphanumeric program name.
 - b. Program Title - English text identification.
 - c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by non-programming-oriented readers.
 2. A program description that shall include, but not be limited to, the following:
 - a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
 - b. Input Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
 - c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.
 - d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.
 - e. Limitations and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.
 - f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.

- g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.
- h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.
- i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

1.10 FINAL SYSTEM DOCUMENTATION

- A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.
- C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.
- D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All

such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.11 PROGRAMS AND SOURCE LISTINGS

- A. Provide one copy of all standard, off-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.
- B. Provide one copy of source listings on digital media, acceptable to Engineer, for all custom software/logic written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.
- C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

1.12 SUBMITTAL/DOCUMENTATION FORMAT

- A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.
- B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in searchable Adobe Portable Document Format (PDF). Raster scans will not be accepted.

1.13 ELECTRONIC O&M MANUALS

- A. Subject to acceptance by the Engineer, the O&M information may be submitted in part or in whole in an electronic format on digital media.
- B. Electronic O&M manuals shall contain information in standard formats (searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible using standard, "off-the-shelf" software such as an Internet browser. Raster scans will not be accepted.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 61 21
PROCESS CONTROL SYSTEM TESTING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall test 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 21.71 – Factory Witness Test
- C. Section 40 61 21.72 – Field Testing
- D. Section 40 61 21.73 – Final Acceptance Test

1.03 SUBMITTALS

- A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:
 - 1. A schedule of all testing to be conducted.
 - 2. A brief description of the testing to be performed
 - 3. Test objectives.
 - 4. Testing criteria per the Specifications.
 - 5. Check lists and procedures for performing each of the specified tests.
 - 6. Sample test result documentation.
 - 7. Requirements for other parties.

1.04 GENERAL REQUIREMENTS

- A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

- B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.
- C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.
- D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.
- E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 40 61 21.71
FACTORY WITNESS TEST

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall perform a Factory Witness Test 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 21.72 – Field Testing
- D. Section 40 61 21.73 – Final Acceptance Test

1.03 FACTORY WITNESS TEST

- A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.
- B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.
- C. Each subsystem shall be fully factory tested for function and operation.
- D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.
- E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.
- F. The instrumentation subcontractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.
- G. The factory testing shall demonstrate all aspects of system sizing and timing including:

1. Monitoring and control scan times at the PLC level.
 2. Response times at the operator workstation level.
- H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.
- I. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:
1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.
 2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.
 3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.
 4. The system shall be operated with data input/output with the PLCs and associated panels to prove operation of all workstation functions.
 5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).
- J. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLCs. This shall include the following:
1. On-line and off-line diagnostics.
 2. For redundant units, fail-over operation and reconfiguration.
 3. System initialization and restart.
 4. Network communications, including fieldbus communications where required.

5. Non-volatility of memory.
 6. Operation of all control logic shall be demonstrated as described herein.
- K. Process I/O Simulation - Process input/output simulation for PLCs shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:
1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLCs and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.
 2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.
 3. To provide data for use at all levels of the control system at the time of system integration.
- L. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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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
- E. Section 40 70 00 – Instrumentation for Process Systems

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. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Section 40 70 00 – Instrumentation for Process Systems.
 - 2. Each final control element shall be individually tested as specified hereinafter.
 - 3. Each control loop shall be tested as specified hereinafter.
 - 4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
 - 5. 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 21.73
FINAL ACCEPTANCE TEST

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall perform the Final Acceptance Test 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 21.72 – Field Testing

1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

- A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner shall be given two (2) weeks' notice of the starting date of the 30-day availability test.
- B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.
 - 1. Downtime of any network-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.
 - 2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.
 - 3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.
 - 4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:

- a. Hard disc (one day)
 - b. Workstations (one day)
 - c. Communication interfaces (eight hours)
 - d. Process control system networks (eight hours)
 - e. Off-line (optical, etc.) storage units (one day)
 - f. UPS unit (one day)
5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.
 6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.
 7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.
 8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.
- C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 30-day period following the restart.
- D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

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 dry contact relay outputs.
- B. 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.
- C. 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 24
QUALITY ASSURANCE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. It is the intent of these Specifications and Drawings to secure high quality in materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All Work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State/Commonwealth, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

- A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- B. For uniformity, only one manufacturer and model will be accepted for each type of product. Where differing models are required, equipment from a single manufacturer shall be provided.
- C. Equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.
- E. Electronic components shall be de-rated to assure dependability and long-term stability.
- F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.
- G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.
- H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

1.04 OPTIONAL EQUIPMENT

- A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate changes with other affected trades and contracts and pay additional charges incurred.

1.05 GUARANTEE

- A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 01 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. Preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe Work performed and list materials used. A copy of service reports shall be delivered to the Owner on the day the Work is performed.
- B. The instrumentation subcontractor shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.
- C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 01 and, in addition, shall meet the following requirements:
 - 1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.
 - 2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of application software upgrades released during the guarantee period.
 - 3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.
 5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.
- D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:
1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.
 2. Provisions for corrective hardware or software maintenance Work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance Work shall be performed by properly trained personnel as described above.
- E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance Work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.06 SHIPPING HANDLING AND STORAGE

- A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.07 FABRICATION

- A. Fabrication of equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.
- B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

- C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Instrumentation and control system installation Work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.
- B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of on-site instrumentation and control system construction Work from commencement of construction through completion and final acceptance.
- C. Labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.
- D. Equipment and materials shall fit properly in their installations. Work required to correct improperly fit installations shall be performed at no additional expense to the Owner.
- E. Work shall be performed in a neat and workmanlike manner. Hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. Wiring shall be neatly bundled, run in wireway, and terminated. Spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Work not meeting these requirements shall be corrected at no expense to the Owner.
- F. Sufficient common-mode and differential-mode noise rejection shall be provided to ensure proper operation of the plant process control system. General practices shall include:
 - 1. Maintaining crossings between noisy wires and signal wires at right angles.
 - 2. Maintaining separation between noisy wires and signal wires as wide as practical.
 - 3. Grounding all signals, shields and power supplies at the process control unit or local control panel.

4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.
 5. Eliminating cable splices. Splices in instrumentation and control system signal, network, and instrument manufacturer furnished cables shall be approved in advance by the Engineer.
 6. Providing a floating output for transmitters that have their own power sources.
- G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.
- H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.
- I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:
1. 120 VAC: 12 in
 2. 240 VAC: 18 in
 3. 480 VAC: 18 in
 4. 2000 VAC and above: 24 in
- J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.
- K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical Work has been completed in the equipment rooms, MCCs, control rooms and all structural and mechanical Work has been completed within 50 feet of equipment locations.
- L. Upon completion of the above construction Work, the Contractor shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all Work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

END OF SECTION

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SECTION 40 61 26
PROCESS CONTROL SYSTEM TRAINING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions

1.03 SUBMITTALS

- A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:
 - 1. A listing of all courses to be conducted.
 - 2. Course content.
 - 3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.
 - 4. Course schedules.
 - 5. Qualifications and experience of individual(s) providing training.
- B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:
 - 1. A listing of all subjects to be covered.
 - 2. Course schedule.
 - 3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

1.04 GENERAL REQUIREMENTS

- A. All costs of providing the training courses shall be borne by the Contractor.

- B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five-day, 40-hour week.
- C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00 pm) to accommodate the working schedule of the Owner's personnel. No additional compensation will be awarded to the Contractor for training at non-standard hours.
- D. All training courses shall complement the experience and skill levels of the Owner's personnel.
- E. Training courses shall be structured in order of increasing capability or security levels. The purpose of this requirement is to allow personnel with lesser training requirements or security password levels to drop out of the training at certain times while the training continues for personnel with greater requirements or higher security levels.
- F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions shall not be acceptable.
- G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.
- H. All training shall be completed prior to system acceptance.
- I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.

1.05 OPERATOR TRAINING

- A. Two one-day courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.
- B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.
- C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.
- D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

1.06 MAINTENANCE TRAINING

- A. A one-day course shall be conducted for at least six persons prior to the start-up of digital equipment at the Owner's plant. Instruction shall be provided in the following:
 - 1. Operating all digital equipment, including system start-up and shutdown procedures.
 - 2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.
 - 3. Calibration and routine maintenance procedures for all analog and digital equipment.
- B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.
- C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off-the-shelf test equipment and to the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

1.07 INSTRUMENT TRAINING

- A. A half-day course shall be provided at the Owner's facilities no more than three months prior to system start-up to instruct a minimum of five persons each in the calibration and preventive maintenance of the field instruments provided under this Contract.

1.08 GENERAL REFRESHER TRAINING

- A. Two half-day general refresher training course shall be provided for up to ten persons 3-6 months after final system acceptance. Instruction shall be given in all aspects of the complete instrumentation and control system. Instructor(s) shall be capable of answering questions related to all aspects and details of the complete system.

PART 2 – PRODUCTS (NOT USED)

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
FE/FIT-331	Clarifier No. 1 Sludge Flow	0 - 350 gpm	4" flow meter, Class 1 Div. 2 area; Remote mounted transmitter
FE/FIT-332	Clarifier No. 2 Sludge Flow	0 - 350 gpm	4" flow meter, Class 1 Div. 2 area; Remote mounted transmitter
FE/FIT-333	Clarifier No. 3 Sludge Flow	0 - 350 gpm	4" flow meter, Class 1 Div. 2 area; Remote mounted transmitter
FE/FIT-334	Clarifier No. 4 Sludge Flow	0 - 350 gpm	4" flow meter, Class 1 Div. 2 area; Remote mounted transmitter

Level Switches (Floats) – Section 40 72 76.26

Tag Number	Service Description	State/Span	Remarks
LSSL-300	Return Sludge PS Low-Low Level	Set @ EL. 621.43	Note 4
LSHH-300	Return Sludge PS High-High Level	Set @ EL. 625.84	Note 4
LSSL-321	Scum Pump Station No. 1 Low Level	-	Notes 3 and 4
LSSL-322	Scum Pump Station No. 2 Low Level	-	Notes 3 and 4

Submersible Level (Pressure) Sensors – Section 40 73 29.13

Tag Number	Service Description	State/Span	Remarks
LE/LT-300	Return Sludge Pump Station Level	0 – 6 ft	Note 1
LE/LT-321	Scum Pump Station No. 1 Level	0 – 7 ft	Note 1
LE/LT-322	Scum Pump Station No. 2 Level	0 – 7 ft	Note 1

Dissolved Oxygen Analyzers – Section 40 75 43.16

Tag Number	Service Description	State/Span	Remarks
AE/AIT-200	Oxidation Tank No. 1	0 – 20 mg/L	120 VAC, analog surge protection & sunshield required. See Note 2.
AE/AIT-201	Oxidation Tank No. 2	0 – 20 mg/L	120 VAC, analog surge protection & sunshield required. See Note 2.

Notes:

1. Device shall be intrinsically safe suitable for use in a Class I, Division 1, Group D environment.
2. Provide 50 feet extension cable for all D.O. probes. Hach Model 57961-00.
3. Coordinate level setting with Scum Pump equipment manufacturer.
4. Switch shall be suitable for use in a Class I, Division 1, Group D environment. Intrinsically safe barrier shall be required.

END OF SECTION

SECTION 40 61 93
PROCESS CONTROL SYSTEM INPUT / OUTPUT LIST

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all control system inputs and outputs as herein specified 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 96 – Process Control Descriptions

PART 2 – CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

Tag Number	Service Description	State/Span	Type	Remarks
YR-201	AERATOR 201	IN AUTO	DI	
YN-201	AERATOR 201	RUN	DI	
YA-201A	AERATOR 201	FAIL	DI	
YA-201B	AERATOR 201	E-STOP	DI	
TAH-201	AERATOR 201	MOTOR OVERTEMP	DI	
YC-201	AERATOR 201	START	DO	
SIR-201	AERATOR 201	SPEED FEEDBACK	AI	
SIC-201	AERATOR 201	SPEED CONTROL	AO	
	AERATOR 201	PHASE A CURRENT	SOFT	
	AERATOR 201	PHASE B CURRENT	SOFT	
	AERATOR 201	PHASE C CURRENT	SOFT	
	AERATOR 201	PHASE A-B VOLTAGE	SOFT	
	AERATOR 201	PHASE B-C VOLTAGE	SOFT	
	AERATOR 201	PHASE C-A VOLTAGE	SOFT	
	AERATOR 201	KW	SOFT	
	AERATOR 201	KVAR	SOFT	
	AERATOR 201	KVA	SOFT	

Tag Number	Service Description	State/Span	Type	Remarks
	AERATOR 201	POWER FACTOR	SOFT	
YR-202	AERATOR 202	IN AUTO	DI	
YN-202	AERATOR 202	RUN	DI	
YA-202A	AERATOR 202	FAIL	DI	
YA-202B	AERATOR 202	E-STOP	DI	
TAH-202	AERATOR 202	MOTOR OVERTEMP		
YC-202	AERATOR 202	START	DO	
SIR-202	AERATOR 202	SPEED FEEDBACK	AI	
SIC-202	AERATOR 202	SPEED CONTROL	AO	
	AERATOR 202	PHASE A CURRENT	SOFT	
	AERATOR 202	PHASE B CURRENT	SOFT	
	AERATOR 202	PHASE C CURRENT	SOFT	
	AERATOR 202	PHASE A-B VOLTAGE	SOFT	
	AERATOR 202	PHASE B-C VOLTAGE	SOFT	
	AERATOR 202	PHASE C-A VOLTAGE	SOFT	
	AERATOR 202	KW	SOFT	
	AERATOR 202	KVAR	SOFT	
	AERATOR 202	KVA	SOFT	
	AERATOR 202	POWER FACTOR	SOFT	
YR-203	AERATOR 203	IN AUTO	DI	
YN-203	AERATOR 203	RUN	DI	
YA-203A	AERATOR 203	FAIL	DI	
YA-203B	AERATOR 203	E-STOP	DI	
TAH-203	AERATOR 203	MOTOR OVERTEMP		
YC-203	AERATOR 203	START	DO	
SIR-203	AERATOR 203	SPEED FEEDBACK	AI	
SIC-203	AERATOR 203	SPEED CONTROL	AO	
	AERATOR 203	PHASE A CURRENT	SOFT	
	AERATOR 203	PHASE B CURRENT	SOFT	

Tag Number	Service Description	State/Span	Type	Remarks
	AERATOR 203	PHASE C CURRENT	SOFT	
	AERATOR 203	PHASE A-B VOLTAGE	SOFT	
	AERATOR 203	PHASE B-C VOLTAGE	SOFT	
	AERATOR 203	PHASE C-A VOLTAGE	SOFT	
	AERATOR 203	KW	SOFT	
	AERATOR 203	KVAR	SOFT	
	AERATOR 203	KVA	SOFT	
	AERATOR 203	POWER FACTOR	SOFT	
YR-204	AERATOR 204	IN AUTO	DI	
YN-204	AERATOR 204	RUN	DI	
YA-204A	AERATOR 204	FAIL	DI	
YA-204B	AERATOR 204	E-STOP	DI	
TAH-204	AERATOR 204	MOTOR OVERTEMP		
YC-204	AERATOR 204	START	DO	
SIR-204	AERATOR 204	SPEED FEEDBACK	AI	
SIC-204	AERATOR 204	SPEED CONTROL	AO	
	AERATOR 204	PHASE A CURRENT	SOFT	
	AERATOR 204	PHASE B CURRENT	SOFT	
	AERATOR 204	PHASE C CURRENT	SOFT	
	AERATOR 204	PHASE A-B VOLTAGE	SOFT	
	AERATOR 204	PHASE B-C VOLTAGE	SOFT	
	AERATOR 204	PHASE C-A VOLTAGE	SOFT	
	AERATOR 204	KW	SOFT	
	AERATOR 204	KVAR	SOFT	
	AERATOR 204	KVA	SOFT	
	AERATOR 204	POWER FACTOR	SOFT	
YR-205	AERATOR 205	IN AUTO	DI	
YN-205	AERATOR 205	RUN	DI	
YA-205A	AERATOR 205	FAIL	DI	

Tag Number	Service Description	State/Span	Type	Remarks
YA-205B	AERATOR 205	E-STOP	DI	
TAH-205	AERATOR 205	MOTOR OVERTEMP		
YC-205	AERATOR 205	START	DO	
SIR-205	AERATOR 205	SPEED FEEDBACK	AI	
SIC-205	AERATOR 205	SPEED CONTROL	AO	
	AERATOR 205	PHASE A CURRENT	SOFT	
	AERATOR 205	PHASE B CURRENT	SOFT	
	AERATOR 205	PHASE C CURRENT	SOFT	
	AERATOR 205	PHASE A-B VOLTAGE	SOFT	
	AERATOR 205	PHASE B-C VOLTAGE	SOFT	
	AERATOR 205	PHASE C-A VOLTAGE	SOFT	
	AERATOR 205	KW	SOFT	
	AERATOR 205	KVAR	SOFT	
	AERATOR 205	KVA	SOFT	
	AERATOR 205	POWER FACTOR	SOFT	
YR-206	AERATOR 206	IN AUTO	DI	
YN-206	AERATOR 206	RUN	DI	
YA-206A	AERATOR 206	FAIL	DI	
YA-206B	AERATOR 206	E-STOP	DI	
TAH-206	AERATOR 206	MOTOR OVERTEMP		
YC-206	AERATOR 206	START	DO	
SIR-206	AERATOR 206	SPEED FEEDBACK	AI	
SIC-206	AERATOR 206	SPEED CONTROL	AO	
	AERATOR 206	PHASE A CURRENT	SOFT	
	AERATOR 206	PHASE B CURRENT	SOFT	
	AERATOR 206	PHASE C CURRENT	SOFT	
	AERATOR 206	PHASE A-B VOLTAGE	SOFT	
	AERATOR 206	PHASE B-C VOLTAGE	SOFT	
	AERATOR 206	PHASE C-A VOLTAGE	SOFT	

Tag Number	Service Description	State/Span	Type	Remarks
	AERATOR 206	KW	SOFT	
	AERATOR 206	KVAR	SOFT	
	AERATOR 206	KVA	SOFT	
	AERATOR 206	POWER FACTOR	SOFT	
AIT-200	OXIDATION TANK NO.1	DISSOLVED OXYGEN	AI	
AIT-201	OXIDATION TANK NO.2	DISSOLVED OXYGEN	AI	
YR-201	OXIDATION TANK NO.1 WEIR	IN REMOTE	DI	
ZI-201	OXIDATION TANK NO.1 WEIR	POSITION FEEDBACK	AI	
ZIC-201	OXIDATION TANK NO.1 WEIR	POSITION CONTROL	AO	
YR-202	OXIDATION TANK NO.2 WEIR	IN REMOTE	DI	
ZI-202	OXIDATION TANK NO.2 WEIR	POSITION FEEDBACK	AI	
ZIC-202	OXIDATION TANK NO.2 WEIR	POSITION CONTROL	AO	
YR-301A	SECONDARY CLARIFIER NO. 301	IN AUTO	DI	
YL-301	SECONDARY CLARIFIER NO. 301	RUNNING	DI	
YA-301	SECONDARY CLARIFIER NO. 301	FAIL	DI	
TAH-301	SECONDARY CLARIFIER NO. 301	MOTOR OVERTEMP	DI	
YC-301	SECONDARY CLARIFIER NO. 301	START	DO	
ZLO-301	MOV-301	OPENED	DI	
ZLC-301	MOV-301	CLOSED	DI	
ZCO-301	MOV-301	OPEN	DO	
ZCC-301	MOV-301	CLOSE	DO	
YR-302A	SECONDARY CLARIFIER NO. 302	REMOTE	DI	
YL-302	SECONDARY CLARIFIER NO. 302	RUNNING	DI	
YA-302	SECONDARY CLARIFIER NO. 302	FAIL	DI	
TAH-302	SECONDARY CLARIFIER NO. 302	MOTOR OVERTEMP	DI	
YC-302	SECONDARY CLARIFIER NO. 302	START	DO	
ZLO-302	MOV-302	OPENED	DI	
ZLC-302	MOV-302	CLOSED	DI	
ZCO-302	MOV-302	OPEN	DO	
ZCC-302	MOV-302	CLOSE	DO	
YR-303A	SECONDARY CLARIFIER NO. 303	REMOTE	DI	

Tag Number	Service Description	State/Span	Type	Remarks
YL-303	SECONDARY CLARIFIER NO. 303	RUNNING	DI	
YA-303	SECONDARY CLARIFIER NO. 303	FAIL	DI	
TAH-303	SECONDARY CLARIFIER NO. 303	MOTOR OVERTEMP	DI	
YC-303	SECONDARY CLARIFIER NO. 303	START	DO	
ZLO-303	MOV-303	OPENED	DI	
ZLC-303	MOV-303	CLOSED	DI	
ZCO-303	MOV-303	OPEN	DO	
ZCC-303	MOV-303	CLOSE	DO	
YR-304A	SECONDARY CLARIFIER NO. 304	REMOTE	DI	
YL-304	SECONDARY CLARIFIER NO. 304	RUNNING	DI	
YA-304	SECONDARY CLARIFIER NO. 304	FAIL	DI	
TAH-304	SECONDARY CLARIFIER NO. 304	MOTOR OVERTEMP	DI	
YC-304	SECONDARY CLARIFIER NO. 304	START	DO	
ZLO-304	MOV-304	OPENED	DI	
ZLC-304	MOV-304	CLOSED	DI	
ZCO-304	MOV-304	OPEN	DO	
ZCC-304	MOV-304	CLOSE	DO	
YR-321	SCUM PUMP NO.1	IN AUTO	DI	
YN-321	SCUM PUMP NO.1	RUNNING	DI	
YA-321	SCUM PUMP NO.1	FAIL	DI	
TAH-321	SCUM PUMP NO.1	MOTOR OVERTEMP	DI	
MAH-321	SCUM PUMP NO.1	LEAK	DI	
LALL-321	SCUM PUMP NO.1	LOW-LOW LEVEL	DI	
YC-321	SCUM PUMP NO.1	START	DO	
LI-321	SCUM PUMP STATION NO.1	LEVEL	AI	
YR-322	SCUM PUMP NO.2	IN AUTO	DI	
YN-322	SCUM PUMP NO.2	RUNNING	DI	
YA-322	SCUM PUMP NO.2	FAIL	DI	
TAH-322	SCUM PUMP NO.2	MOTOR OVERTEMP	DI	
MAH-322	SCUM PUMP NO.2	LEAK	DI	
LALL-322	SCUM PUMP NO.2	LOW-LOW LEVEL	DI	

Tag Number	Service Description	State/Span	Type	Remarks
YC-322	SCUM PUMP NO.2	START	DO	
LI-322	SCUM PUMP STATION NO.2	LEVEL	AI	
YR-331	MOV-331	IN REMOTE	DI	
ZI-331	MOV-331	POSITION FEEDBACK	AI	
ZIC-331	MOV-331	POSITION CONTROL	AO	
FI-331	CLARIFIER NO.1 SLUDGE FLOW	FLOW	AI	
YR-332	MOV-332	IN REMOTE	DI	
ZI-332	MOV-332	POSITION FEEDBACK	AI	
ZIC-332	MOV-332	POSITION CONTROL	AO	
FI-332	CLARIFIER NO.2 SLUDGE FLOW	FLOW	AI	
YR-333	MOV-333	IN REMOTE	DI	
ZI-333	MOV-333	POSITION FEEDBACK	AI	
ZIC-333	MOV-333	POSITION CONTROL	AO	
FI-333	CLARIFIER NO.3 SLUDGE FLOW	FLOW	AI	
YR-334	MOV-334	IN REMOTE	DI	
ZI-334	MOV-334	POSITION FEEDBACK	AI	
ZIC-334	MOV-334	POSITION CONTROL	AO	
FI-334	CLARIFIER NO.4 SLUDGE FLOW	FLOW	AI	
YR-311	RETURN SLUDGE PUMP P-311	IN AUTO	DI	
YN-311	RETURN SLUDGE PUMP P-311	RUNNING	DI	
YA-311	RETURN SLUDGE PUMP P-311	FAIL	DI	
TAH-311	RETURN SLUDGE PUMP P-311	MOTOR OVERTEMP	DI	
MAH-311	RETURN SLUDGE PUMP P-311	LEAK	DI	
YC-311	RETURN SLUDGE PUMP P-311	START	DO	
YR-312	RETURN SLUDGE PUMP P-312	IN AUTO	DI	
YN-312	RETURN SLUDGE PUMP P-312	RUNNING	DI	
YA-312	RETURN SLUDGE PUMP P-312	FAIL	DI	
TAH-312	RETURN SLUDGE PUMP P-312	MOTOR OVERTEMP	DI	
MAH-312	RETURN SLUDGE PUMP P-312	LEAK	DI	
YC-312	RETURN SLUDGE PUMP P-312	START	DO	

Tag Number	Service Description	State/Span	Type	Remarks
YR-313	RETURN SLUDGE PUMP P-313	IN AUTO	DI	
YN-313	RETURN SLUDGE PUMP P-313	RUNNING	DI	
YA-313	RETURN SLUDGE PUMP P-313	FAIL	DI	
TAH-313	RETURN SLUDGE PUMP P-313	MOTOR OVERTEMP	DI	
MAH-313	RETURN SLUDGE PUMP P-313	LEAK	DI	
YC-313	RETURN SLUDGE PUMP P-313	START	DO	
YR-314	RETURN SLUDGE PUMP P-314	IN AUTO	DI	
YN-314	RETURN SLUDGE PUMP P-314	RUNNING	DI	
YA-314	RETURN SLUDGE PUMP P-314	FAIL	DI	
TAH-314	RETURN SLUDGE PUMP P-314	MOTOR OVERTEMP	DI	
MAH-314	RETURN SLUDGE PUMP P-314	LEAK	DI	
YC-314	RETURN SLUDGE PUMP P-314	START	DO	
LI-300	RETURN SLUDGE PUMP STATION	LEVEL	AI	
LAHH-300	RETURN SLUDGE PUMP STATION	HIGH-HIGH LEVEL	DI	
LALL-300	RETURN SLUDGE PUMP STATION	LOW-LOW LEVEL	DI	
FI-301	DIGESTER SLUDGE FLOW	FLOW	AI	
FI-302	OXIDATION TANK NO.1 SLUDGE FLOW	FLOW	AI	
FI-303	OXIDATION TANK NO.2 SLUDGE FLOW	FLOW	AI	
	POWER MONITOR	PHASE A CURRENT	SOFT	
	POWER MONITOR	PHASE B CURRENT	SOFT	
	POWER MONITOR	PHASE C CURRENT	SOFT	
	POWER MONITOR	PHASE A-B VOLTAGE	SOFT	
	POWER MONITOR	PHASE B-C VOLTAGE	SOFT	
	POWER MONITOR	PHASE C-A VOLTAGE	SOFT	
	POWER MONITOR	KW	SOFT	
	POWER MONITOR	KVAR	SOFT	
	POWER MONITOR	KVA	SOFT	
	POWER MONITOR	POWER FACTOR	SOFT	
	POWER MONITOR	FREQUENCY	SOFT	

1. NOTES: Input/Output types are as follows:
 - a. DI – Discrete Input
 - b. DO – Discrete Output
 - c. AI – Analog Input
 - d. AO – Analog Output
 - e. SOFT – Ethernet/IP Communications Link

PART 3 – EXECUTION (NOT USED)

END OF SECTION

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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 91 – Process Control System Instrument List
- C. Section 40 61 93 – Process Control System Input/Output List
- D. Section 40 68 00.13 – Process Control Software (Modify)

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 overtorque, 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.

2.04 HMI DISPLAY GRAPHICS

A. SCADA HMI

1. SCADA HMI graphics for the process controls described in this section shall be integrated into the plant's existing HMI system in accordance with Section 40 68 00.13.

2. New Operator Interface Terminal (OIT) graphics for the process controls described in this section shall be produced and displayed on the new OIT at PLC-RAS.
3. All reference to HMI in this section refers to both the SCADA HMI and the OIT graphics.

PART 3 – FUNCTIONAL CONTROL DESCRIPTIONS

3.01 OXIDATION TANKS

A. Process Overview

1. The Instrumentation Subcontractor shall furnish a new PLC at the new MCC-RAS Electrical Canopy, designated as PLC-RAS, as shown on the Drawings. The Instrumentation Subcontractor shall provide programming in PLC-RAS to accommodate the new aeration system that includes six (6) new rotary disc surface aerators with VFDs and two (2) dissolved oxygen analyzers.
2. PLC-RAS shall include the aeration system control programs for the Oxidation Tanks. The control strategies shall operate independently and shall include the following aeration control functions:
 - a. Disc Aerator Monitoring
 - b. Disc Aerator Baseline Operation
 - c. Alternative Dissolved Oxygen (D.O.) Control Program

B. Control Equipment

1. Two (2) new luminescent dissolved oxygen analyzers with analog input to PLC-RAS:

DO Analyzer	Service
AE/AIT 200	Oxidation Tank No. 1 Dissolved Oxygen
AE/AIT 201	Oxidation Tank No. 2 Dissolved Oxygen

2. The six (6) new rotary disc surface aerators shall be provided with a variable frequency drive (VFD) as specified in Section 46 51 19. Mixing intensity and airflow of the aerators shall be controlled through operating speed adjustment. Each disc aerator shall include:
 - a. HAND-OFF-AUTO selector switch
 - b. CONTROL POWER indication light
 - c. RUN indication light
 - d. MOTOR OVERTEMP indication light
 - e. FAIL indication light
 - f. Elapsed RUN TIME meter (Non-Resettable)

C. Control Operations

1. Each disc aerator shall be started via variable frequency drive (VFD) starter, either remotely from SCADA or locally at the PLC-RAS.
2. Analog input data from the analytical process instruments (DO analyzers) shall be continuously trended to SCADA. Data shall be utilized for process control as described herein.
3. Disc Aerator Monitoring
 - a. Disc aerator monitoring and protection from abnormal operating conditions shall be provided by the PLC-RAS. Status and alarm information for the disc aerators shall be displayed on the HMI.
4. Disc Aerator Baseline Operation
 - a. When the HAND-OFF-AUTO (L-O-A) selector switch for a disc aerator is in the HAND position, the equipment shall operate. When the H-O-A switch is in the OFF position, the equipment shall not operate under any condition. When the H-O-A switch is in the AUTO position, the equipment shall be started and stopped remotely from the PLC.
 - b. Under normal conditions, all six (6) disc aerators shall be kept in service using AUTO mode. A graphic display shall be provided for monitoring D.O. concentrations in each Oxidation Tank. This display shall also indicate any alarms that are received from the disc aerators, VFDs, etc.
 - c. Under the PLC control, the equipment shall be provided with remote manual operation from the SCADA HMI.
5. Alternative Dissolved Oxygen (D.O.) Control Program
 - a. Two (2) independent control programs shall be provided for maintaining dissolved oxygen concentration setpoints in the dual Oxidation Tanks.

Service	Disc Aerators	DO Analyzer	DO Control Setpoint Range (mg/L)	Initial DO Control Setpoint (mg/L)
Oxidation Tank No. 1	AER-201, 202, 203	AE/AIT 200	0.5 - 3.5	2.0
Oxidation Tank No. 2	AER-204, 205, 206	AE/AIT 201	0.5 - 3.5	2.0

- b. A graphic display shall be furnished for enabling and disabling the strategy and for modification of the setpoints, deadbands, and control input for D.O. control. These programs shall use the data trended from the two (2) new D.O. analyzers in order to control the speed of the disc aerator VFDs.
- c. The D.O. control programs shall regulate the speed of the respective disc

aerator VFDs based on the respective D.O. analyzer's process variable.

- d. The three (3) disc aerator VFDs for each Oxidation Tank shall initially be set to full speed (i.e. 60 Hz). In order to achieve the D.O. control setpoint, the operating speed of one (1) of the disc aerator VFDs shall be automatically adjusted, until the D.O. concentration is within the deadband. This disc aerator VFD shall be referred to as the "regulating" VFD.
- e. The disc aerator VFD that is designated as the regulating VFD shall be rotated every 24 hrs between the three (3) disc aerator VFDs dedicated to each Oxidation Tank.
 - i. If the regulating VFD reaches minimum speed in order to achieve the D.O. setpoint (confirm the minimum speed with manufacturer), then that VFD's speed shall be set at the minimum and another one of the other disc aerator VFDs associated with the same Oxidation Tank shall become the regulating VFD.
- f. The running average D.O. for an Oxidation Tank shall be calculated over a 60-minute time period (30 second samples). The operator shall have the ability to adjust the sample time for each Oxidation Tank. When the sampling time has expired the average D.O. shall be compared against the following statements and the speed of the aerator adjusted accordingly. No additional speed adjustments shall be made until the sampling time has expired again.
 - i. If the average D.O. concentration is outside of 0.50 mg/L of the setpoint, then the regulating VFD for that Oxidation Tank shall have its speed modified by 10 % (slower or faster) in order to adjust towards the D.O. concentration setpoint.
 - ii. If the average D.O. concentration is between 0.15 mg/L to 0.50 mg/L of the setpoint, then the regulating VFD for that Oxidation Tank shall have its speed modified by 5 % (slower or faster) in order to adjust towards the D.O. concentration setpoint.
 - iii. If the average D.O. concentration is between 0.01 mg/L to 0.15 mg/L of the setpoint, then the regulating VFD for that Oxidation Tank shall have its speed modified by 2 % (slower or faster) in order to adjust towards the D.O. concentration setpoint.
- g. If any disc aerator or VFD is out of service, then the Oxidation Tank associated with that equipment shall not be allowed to operate using the Alternative Dissolved Oxygen (D.O.) Control Program.

6. Software Interlocks

- a. If any one of the aerator emergency stops are activated all six (6) of the aerators shall be stopped.

7. Weir Gates MOG-201 and MOG-202

- a. When the weir gate's L-R switch is in the LOCAL position, the gate shall open when the local O-S-R switch is in the OPEN position, stop when the switch is in the STOP position, and close when the switch is in the CLOSE position. With the L-R switch in the REMOTE position the gate shall be controlled by the analog position command from the PLC.
- b. When in REMOTE the operator shall have the ability to manually set the position setpoint from the HMI.

3.02 SECONDARY CLARIFIERS

A. Process Overview

1. The four (4) secondary clarifiers shall

B. Control Equipment

1. Each clarifier shall be provided with a new MCC-RAS bucket for power and control functionality:
 - a. IN AUTO discrete inputs to PLC
 - b. RUNNING discrete input to PLC
 - c. FAIL discrete input to PLC
 - d. HIGH MOTOR TEMP discrete input to PLC
 - e. START discrete output from PLC

C. Control Operation

1. When the clarifier H-O-A switch is in the HAND position, the clarifier shall run continuously. With the H-O-A switch in OFF, the clarifier shall not operate under any condition. When the H-O-A switch is in the AUTO position, the clarifier shall be controlled by manual START/STOP pushbuttons from the HMI.

D. Existing Controls

1. **The four secondary clarifiers are currently controlled from the ADMIN-PLC which has a Allen-Bradley CompactLogix L32E processor and a Square-D Magelis operator interface terminal.**
2. **The existing PLC code and OIT graphics associated with the secondary clarifiers shall be removed.**

3.03 SCUM BOX SPRAY HEADERS

A. Process Overview

1. The scum boxes for the four (4) clarifiers shall include stainless steel spray headers with nozzles and actuated ball valves. The actuated ball valves shall be automatically opened periodically to flush the scum boxes with pressurized water.

B. Control Equipment

1. Each clarifier shall be provided with one (1) electric actuated ball valve for the scum box and shall include:
 - a. OPEN/CLOSE discrete outputs from PLC
 - b. 100% OPEN discrete input to PLC
 - c. 100% CLOSED discrete input to PLC

Location	Valve Tag	Service
Clarifier No. 301	MOV-301	Spray Water
Clarifier No. 302	MOV-302	Spray Water
Clarifier No. 303	MOV-303	Spray Water
Clarifier No. 304	MOV-304	Spray Water

C. Control Operation

1. Each of the actuated ball valves shall be normally closed, and actuated periodically to provide spray water to the scum beaches. Initially, the ball valves shall be opened every 10 minutes, for 20 second intervals; the timing setpoints shall be operator adjustable. The four ball valves shall open at different times so that the non-potable water system pressure is not affected.

3.04 SCUM PUMPING

A. Process Overview

1. Three submersible centrifugal chopper pumps shall be provided as specified under Division 43 (one shall be an uninstalled spare). Scum Pump Station No. 1 and Scum Pump Station No. 2 shall each include one installed chopper pump as shown on the Drawings. Primary scum shall be pumped from the scum pump stations to Digester Nos. 1 and 2 or the sludge drying beds where the operator can manually choose to send flow to Digesters No. 1 / 2 or the drying beds.

B. Control Equipment

1. Submersible level pressure sensor and low-level float shall be provided in each primary scum pump station as shown on the Drawings.

Equipment	Scum Pump Station No. 1	Scum Pump Station No. 2
Scum Pump	P-301	P-302
Submersible (Pressure) Level Sensor	LE/LT-321	LE/LT-322
LSLL Float	LSLL-321	LSLL-322

C. Control Operations

1. When the scum chopper pump H-O-A switch is in the HAND position, the pump shall run continuously. With the H-O-A switch in OFF, the pump shall not operate under any condition. When the H-O-A switch is in the AUTO position, the pump shall be controlled by START/STOP commands from the PLC based on level settings in the scum manhole.
2. The PLC shall control the scum chopper pump in each scum pump station with the following initial settings:

Wet Well Level ⁽¹⁾	Action
6.00	High level alarm / Start pump
5.50	Start pump
3.50	Stop pump
3.00	Low-Low level alarm / Stop pump (Float)

- (1) Water elevations given are initial settings and shall be coordinated with the requirements of the equipment supplied.
- (2) Levels shall be adjusted to be suitable for each pump station, noting that they have different depths.

3.05 SLUDGE FLOW CONTROL VAULTS

A. Process Overview

1. Four (4) new sludge flow control vaults shall be provided to control the sludge flow from each of the Clarifiers into the Return Sludge Pump Station.

B. Control Equipment

1. Each vault will contain one (1) 4" flow meter and one (1) 4" modulating plug valve as shown on the Drawings and as specified per Sections 40 71 13.13 and 40 05 62, respectively. Each of the modulating plug valves shall be supplied with a remote local control station supplied by the actuator vendor.

Equipment	Sludge Flow Control Vault No. 1	Sludge Flow Control Vault No. 2	Sludge Flow Control Vault No. 3	Sludge Flow Control Vault No. 4
Magnetic Flow Meter	FE/FIT-331	FE/FIT-332	FE/FIT-333	FE/FIT-334
Modulating Plug Valve	MOV-331	MOV-332	MOV-333	MOV-334

C. Control Operations

1. When the sludge flow valve's L-R switch is in the LOCAL position, the valve shall open when the local O-S-R switch is in the OPEN position, stop when the switch is in the STOP position, and close when the switch is in the CLOSE position. With the L-R switch in the REMOTE position the valve shall be controlled by the analog position command from the PLC.
2. When in REMOTE/MANUAL the operator shall have the ability to manually set the position setpoint from the HMI.
3. When in REMOTE/AUTO the valve will automatically adjust its position to maintain the flow setpoint entered by the operator. The initial flow setpoint shall 275 GPM.

3.06 RETURN SLUDGE PUMP STATION

A. Process Overview

1. Each RAS pump and WAS pump shall be started via direct-drive motor starter, either remotely from SCADA or locally at the MCC-RAS. When any pump is not in AUTO mode an alarm will be sent to SCADA.

B. Control Equipment

1. The Return Sludge Pump Station includes three (3) submersible RAS pumps, one (1) submersible WAS pump, a submersible level pressure sensor (LE/LT-300), and high-high / low-low level floats (LSHH / LSLI-300) as shown on the Drawings. The control equipment shall be as specified in Division 40.

C. Control Operations

1. Each pump shall be enabled for operation through SCADA. Equipment status and alarms shall be indicated through the HMI.

2. When the return sludge pump H-O-A switch is in the HAND position, the pump shall run continuously. With the H-O-A switch in OFF, the pump shall not operate under any condition. When the H-O-A switch is in the AUTO position, the pump shall be controlled by START/STOP commands from the PLC.
3. When the pump is AUTO/MANUAL the operator shall have the ability to manually start/stop the pump from the HMI.
4. When the pump is AUTO/AUTO the PLC shall control the pumps as follows:
 - a. RAS pumps shall be operated in lead/lag status. Status shall alternate on a programmed timed basis (e.g. 1 day, or 24 hours). When a RAS pump is called / enabled for operation from the SCADA, the associated motor starter will be energized.
 - b. Wetwell level control shall be used to determine the number of RAS pumps operating. When the Lag-1 level setpoint is reached and maintained for an adjustable time period (e.g. 5 minutes), the subsequent "lag" pump shall be called to start. When multiple RAS pumps are operating and flows decrease to where the associated low level setpoint is reached and maintained for an adjustable time period, the "lag" pump will be called to stop.

Wet Well Level	Action
9.00	High-High level alarm / Start Lag-2 pump
7.50	Start Lag-1 pump
6.00	Start Lead pump
5.00	Stop Lag-2 pump
4.00	Stop Lag-1 pump
2.00	Stop Lead pump
1.50	Low-Low level alarm

- c. The WAS pump shall be operated independently of the RAS pumps, including remote manual control via SCADA. The WAS pump shall not be allowed to operate if the wetwell level is below 2.00-ft.
- d. The integrator shall include the following options for WAS pump operation:
 - 1) Timed operation set manually (e.g. set a timer to operate the WAS pump for 30 minutes)
 - 2) Scheduled operation (e.g. operate the WAS pump for 10 minutes out of every 60 minutes)

D. **Existing Controls**

1. **The four return sludge pumps are currently controlled from the ADMIN-PLC which has a Allen-Bradley CompactLogix L32E processor and a Square-D Magelis operator interface terminal.**
2. **The existing PLC code and OIT graphics associated with the return sludge pumps shall be removed.**

END OF SECTION

SECTION 40 62 63
OPERATOR INTERFACE TERMINALS (OIT)

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all operator interface units, 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 63 43 – Programmable Logic Controllers

PART 2 – PRODUCTS

2.01 OPERATOR INTERFACE UNIT – LARGE

- A. An Operator Interface Terminal (OIT) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIT shall provide the following features as a minimum:
 - 1. Minimum of 10.4 inch diagonal display
 - 2. 18-bit color TFT LCD 800 x 600 SVGA display
 - 3. Backlit analog resistive touch screen interface w/ 1 million press actuation rating
 - 4. Backlight w/ min. 50,000 hour life to half brightness
 - 5. Minimum of 512 MB internal storage
 - 6. Minimum of 512 MB RAM application memory
 - 7. Minimum of 80 MB nonvolatile user memory
 - 8. Windows CE Operating System
 - 9. Battery-backed real-time clock
 - 10. Secure Digital (SD) card slot w/ min. 2 GB card

11. One USB 2.0 high-speed Type A host port; one USB 1.0 high-speed Type B device port
 12. One 10/100Base-T Auto MDI/MDI-X Ethernet port
 13. Windows-based configuration software complete with download cable
 14. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
 15. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
 16. Environment: 0-55°C, 5-95% relative humidity, non-condensing
- B. The operator interface unit shall be Allen-Bradley PanelView Plus 7 Standard 1000, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. The OIT shall be configured to display all PLC I/O, setpoints, and parameters. All equipment failures shall be alarmed. PLC I/O values and operator-entered setpoints shall be displayed with associated units and service descriptions. Menus shall be provided to navigate between screens of different equipment items. Displays shall be arranged in a hierarchical structure with displays for specific equipment items grouped together. Additional functionality shall be as specified elsewhere in this Division.
- B. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.
- C. Unless otherwise indicated, each OIT shall be mounted between 48 and 60 inches above the floor or work platform.
- D. Refer to Section 40 61 13 – Process Control System General Provisions, for additional requirements.

END OF SECTION

SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers (PLC), 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 61 23 – Signal Coordination Requirements
- C. Section 40 62 63 – Operator Interface Units
- D. Section 40 66 00 – Process Control System Networks
- E. Section 40 67 63 – Uninterruptible Power Systems
- F. Section 40 67 00 – Control System Equipment Panels and Racks

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. The following specific spare parts items shall be provided:
 - 1. One of each type and size of module for PLC equipment furnished under this Contract.
 - 2. One of each type and size of PLC and equipment power supply furnished under this Contract.

PART 2 – PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

- A. The instrumentation subcontractor shall furnish programmable controllers (PLCs) as specified herein and as shown on the Drawings. PLCs shall be provided complete with backplane, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.

- B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.
- C. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.
- D. Where applicable, the minimum PLC backplane size shall be 7 slots, not including power supply slots.
- E. System configuration shall be as shown on the Control System Architecture Drawing. PLC types shall be designated on the Control System Architecture Drawing and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. Memory and processor shall be adequate for all control functions specified. PLCs shall be as manufactured or equal to the following:
 - 1. Allen-Bradley CompactLogix with L3 processor

2.02 PROCESSORS

- A. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low.

- B. The instruction set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:
 - 1. Ladder Diagram
 - 2. Structured Text
 - 3. Instruction List
 - 4. Function Block Diagram
 - 5. Sequential Function Chart
- C. Additional co-processors or modules may be necessary and shall be furnished as required to meet the functions specified herein and in Section 40 61 96 – Process Control Descriptions.
- D. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

2.03 COMMUNICATIONS

- A. PLC communications shall be provided as specified in Section 40 66 00 – Process Control System Networks and as shown on the Control System Architecture Drawing.
- B. In addition to a communications port for the control system network, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.
- C. The PLC shall be able to support various types of fieldbus communication systems for data links to field instruments (where specified) in addition to connected equipment such as power monitors, VFDs, motor protection monitors, etc. As a minimum, Profibus DP, Foundation Fieldbus, Modbus RTU Master and Slave, TCP/IP Ethernet shall be supported. The Contractor shall coordinate the efforts of the necessary parties (instrumentation subcontractor and equipment suppliers) to accomplish the required device and data table addressing between each PLC and the associated connected equipment.
- D. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract and shall be supplied at no extra cost to the Owner.

2.04 INPUT/OUTPUT SUBSYSTEMS

- A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.
- B. Discrete inputs shall be 24 VDC or 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 24 VDC or 120 VAC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 40 61 23 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 40 78 00 – Panel Mounted Instruments. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.
- C. Analog input circuits shall be isolated, minimum 16-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTDs. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 40 78 56 – Isolators, Intrinsically-Safe Barriers, and Surge Suppressors. Maximum density for analog I/O modules shall be 8 per module.
- D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.
- E. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have

a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

2.05 INPUT/OUTPUT CIRCUIT ARRANGEMENT

- A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. PLC programming shall be furnished to perform all functions described in Section 40 61 96 – Process Control Descriptions, including global functions. In addition, PLCs shall be programmed to provide additional functions described in other Sections of this Division.
- B. PLC programming shall make use of the various IEC languages as appropriate to the specific task and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease of modification of the program code through the elimination of multiple instances of repeated code for the same function in a “hard-coded” style.
- C. Extensive comments shall be placed in the program code to describe the functions of all elements of the program code. PLC code that does not contain comments shall be rejected.
- D. Refer to Section 40 61 13 – Process Control System General Provisions, Part 3 for additional requirements.

3.02 REQUIREMENTS FOR MANUFACTURER-SUPPLIED PLCS

- A. PLCs that are supplied for equipment local control panels by individual equipment manufacturers or suppliers shall, where so indicated on the Control System Architecture Drawing, be integrated into the plant control system. The manufacturer-supplied PLC shall be furnished, installed and programmed by the manufacturer. The PLC shall continuously monitor and control the associated system and at the same time shall provide all the required alarms, indications of system parameters, equipment status, etc. to the main control system at the plant.
- B. Where required as described above, each manufacturer-supplied PLC shall be connected to the Ethernet process control network for access from the plant control

system HMI servers, as specified in Section 40 66 00 – Network and Communication Equipment, and shall contain a fiber optic Ethernet switch identical to those provided for the rest of the network-connected PLCs.

- C. Each equipment manufacturer shall provide all monitoring and control data to be transferred between the PLC and the plant control system in contiguous blocks of PLC registers to facilitate block read and write commands for efficient scanning by the control system SCADA servers. These contiguous registers shall be arranged in a single data transfer area, which shall be divided into eight distinct areas with an emphasis on flexibility and future expansion. The distinct areas shall be arranged by data type (analog or discrete), transfer direction (server to PLC or PLC to server), and, where applicable, implementation schedule (current or future). Where required, peer-to-peer communication between PLCs shall likewise be accomplished using separate blocks of contiguous registers. Where individual equipment PLCs are not required to be connected to the plant control system via the data highway network, they shall provide the individual hardwired signals as specified in the Contract Documents. Data and commands for connection to the control system are described in the Drawings, the Input/Output Schedule, the individual equipment Specification Sections, and in Section 40 61 96 – Process Control Descriptions.
- D. The operator interface for control of each individual system shall be performed by local operator interface units as specified in Section 40 62 63 – Operator Interface Terminals or individual pilot devices on the equipment local control panel, as specified in the associated equipment Specification Section. Additional operator interface functions shall be provided through the plant control system as specified in the respective equipment specifications and in Section 40 61 96 – Process Control Descriptions.
- E. Where operator interface and control functions are required to be provided through the plant control system, the individual system supplier shall be responsible for coordination with the instrumentation subcontractor to provide a complete and working equipment control system. The individual equipment supplier shall also be responsible for limiting the access of the plant control system to the equipment PLC code so as to prevent malfunctions of the equipment and any failure to continuously perform its intended functions. The equipment supplier shall be responsible for ensuring that no actions by the plant control system can damage or otherwise adversely affect the operation of the associated equipment or the safety of personnel working on or near that equipment. The equipment supplier shall also provide direction in the configuration of the SCADA software's security system by the instrumentation subcontractor to limit access to the control functions of the equipment control system to authorized personnel only. The equipment supplier shall coordinate testing of the completed system with the instrumentation subcontractor, which shall conform to the requirements of Section 40 61 21.72 – Field Testing.
- F. The Contractor, equipment supplier and instrumentation subcontractor shall coordinate testing and startup of the equipment provided by the equipment supplier with the plant control system, including but not limited to the following tasks:

1. Provide assistance with control system testing of inputs, outputs, and control strategies as needed.
2. Provide support or interface work necessary to perform physical checkout and field testing to the final field devices. The schedule may require the instrumentation subcontractor and equipment manufacturer personnel to perform loop checks simultaneously, as directed by the Engineer.
3. Coordinate and assist as needed to maintain I/O connectivity throughout the system.
4. Ensure personnel safety while equipment is exercised via the plant control system.
5. Ensure that process, instrumentation, and control equipment are not damaged while equipment is exercised via the plant control system.
6. Provide temporary modifications to field devices and their terminations, if needed.
7. Providing labor and supervision, which may include, but is not limited to, the following: electricians, instrument technicians, manufacturer's representatives, and individual(s) knowledgeable about process startup and operation.
8. Operation of process equipment for verification of each plant control system input and output.

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SECTION 40 66 00
PROCESS CONTROL SYSTEM NETWORKS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 Ethernet local area network(s) for communications among plant devices.
- B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 63 43 – Programmable Logic Controllers
- C. Section 40 62 16 – Operator Workstation Computers

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. The following specific spare parts items shall be provided:
 - 1. A termination tool kit shall be provided containing all required tools and consumables for up to 25 connections of each connection type furnished. Termination kit shall be as manufactured by Black Box, Corning Cable Systems, Optical Cable Corporation, or equal.
 - 2. One spare switch of each type furnished under this Contract.

PART 2 – PRODUCTS

2.01 LOCAL AREA NETWORK (LAN)

- A. An IEEE 802.3 Ethernet local area network shall be used for communications between plant devices.
- B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.

- C. The Contractor may provide a network configuration different from that shown in the Contract Drawings with written approval of the Engineer, but the Contractor shall coordinate with all affected trades and pay for all additional charges incurred.
- D. The Contractor shall supply all hardware, cables, connectors, and software to implement a network as specified herein and shown on drawings.

2.02 INDUSTRIAL ETHERNET NETWORK SWITCHES

- A. Except where specifically allowed on the Control System Architecture Drawing, industrial Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.
- B. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending faults. Ethernet network switches shall be replaceable on-line without disrupting the network. The Ethernet network switches shall be integrated into the in-plant Ethernet network to form a redundant ring network with self-healing communication recovery. Switches shall support the non-proprietary Media Redundancy Protocol (MRP) and Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, all of which shall provide self-healing communication recovery.
- C. Ethernet network switches shall meet the following minimum performance requirements:
 - 1. Functions: Modular managed switch with store and forward switching mode, 10 Mbps Ethernet, or 100 Mbps Fast-Ethernet, or gigabit Ethernet support, multi-address capability, auto-crossing, auto-negotiation, auto-polarity. Port speed and duplex auto-negotiation shall be configurable. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.
 - 2. Management: Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.
 - 3. Power Requirements: Redundant 24 VDC power supply
 - 4. Operating Temperature: 0 to 60 degrees C
 - 5. Relative Humidity: 10 - 95%
 - 6. Network Size: Up to 50 nodes in ring structure

7. Port Type & Quantity (at each PLC location): minimum of four eight (48) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment and two (2) 100/1000Base-FX, multimode fiber optic cables (62.5/125 μm), LC, ST or SC sockets, 0-5000 meters LAN segment
 8. Link Budget: 8 dB @ 1300 nm; 10 dB @ 850 nm
 9. Wavelength: 850 or 1300 nm
- D. Acceptable industrial Ethernet network switches shall be as manufactured by Cisco Systems, Hirschmann, Phoenix Contact, Weidmuller, or equal.

2.03 UNSHIELDED TWISTED PAIR CABLE

- A. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek, Belden equivalent, or equal. Connectors shall be modular RJ-45 plug.

2.04 FIBER OPTIC CABLE

- A. Fiber optic cable shall conform to the following specifications:
1. Fiber Type: Graded Index (GI) Multimode
 2. Fiber/Cladding Diameter: 62.5/125 microns
 3. No. Fibers: 12, Color-coded
 4. Cable Construction: Loose Tube w/ Ripcords
 5. Filling: Water Swellable Dry Block
 6. Armored: No
 7. Central Member: Dielectric (Kevlar)
 8. Rating: Gigabit Ethernet
 9. Bandwidth: 200/500 MHz-km at 850/1300 nm
 10. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm
 11. Application Type: Direct-burial/Conduit/Aerial
 12. Sheath: UV Resistant

13. Max. Tensile Load: 600 lb (2700 N) installation; 200 lb (890 N) long term
 14. Minimum Bend Radius: 7 in (17.4 cm) under maximum tensile load; 4.6 in (11.6 cm) unloaded (installed)
 15. Operating Temperature: -40 to 70 degrees C
 16. Operating Relative Humidity: 0 to 100%
- B. Fiber optic cable shall be ALTOS All Dielectric Loose Tube Optical Cable as manufactured by Corning Cable Systems, the Extended Performance Fiber Optic Cable Series as manufactured by Phoenix Digital, Inc., Belden equivalent, equivalent system by Optical Cable Corporation, or equal.
- C. Upon entering a cabinet, panel or console, loose tube fiber optic cable shall be broken out using fan-out kits and terminated in a fiber optic patch panel. All individual fibers shall be terminated and all connections shall be tested. Tight buffered cable shall then be routed to the individual destinations as needed (or loose tube cable for runs to other buildings). Cabinet-mounted patch panels shall be Cabinet-Mounted Interconnect Center (C-MIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.
- D. Where cable is required to be routed to numerous, separate destinations within a building, loose tube cable shall be broken out immediately upon entering the building, all individual fibers terminated in a patch panel, and tight buffered, plenum rated cable shall be routed to the individual destinations. Building patch panels shall be Wall-Mountable Interconnect Center (WIC) or Premises Interconnect Center (PIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.
- E. Fiber optic cable for installation within buildings shall comply with all applicable fire and building safety codes for such applications.
- F. Fiber optic cable shall utilize mechanically spliced, field installable, SC, LC, or ST compatible connectors. Connections shall have a typical loss of 0.35 dB or better and shall provide stable optical performance after numerous rematings. Connections shall utilize physical contact terminations utilizing UV or heat cured adhesive. Where applicable, field terminations shall use a simple procedure requiring minimal training.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.

- B. Refer to Section 40 61 13 – Process Control System General Provisions Part 3 of the Specifications for additional requirements.

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SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place, in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.
- B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.
- C. Either manufacturer's standard or custom enclosures may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.
- D. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and field inspect new and existing structures as required to determine installation requirements and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).
- E. The terms enclosure, cabinet, and panel shall be considered the same product and are used interchangeably.

1.02 SUBMITTALS

- A. Submittals shall be per Section 40 61 15 – Process Control System Submittals.
- B. Thermal calculations.
- C. Proof of circuit breaker selective coordination.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 78 00 – Panel Mounted Instruments
- C. Section 40 78 56 – Isolators, Intrinsically-Safe Barriers, and Surge Suppressors

- D. Section 40 70 00 – Instrumentation for Process Systems
- E. Refer to Division 26 for additional requirements for conductors, circuit breakers, disconnect switches, etc.

1.04 PANEL LOCATION AND TYPE

- A. For locations inside buildings in areas other than climate controlled (i.e., heated and air conditioned) electrical or control rooms, panel shall be Type 316 stainless steel NEMA 4X construction, or as indicated for hazardous area classification (Class, Division, at a minimum), or submersible, NEMA 6, applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications.
- B. For locations in storage/feed areas for chlorine or other applicable corrosive chemicals, panel shall be of non-metallic construction, rated NEMA 4X, and be fully compatible with the associated chemical.
- C. For locations within climate controlled (i.e., heated and air-conditioned) electrical or control rooms, panel shall be a painted steel fully enclosed NEMA 12 units with gasketed doors.
- D. For outdoor locations, panel shall be Type 316L stainless steel NEMA 4X construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.

PART 2 – PRODUCTS

2.01 CABINETS AND PANELS

- A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.
- B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
- C. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.

- D. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits. Coordinate keying with Owner.
- E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- F. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.
- G. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.
- H. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

2.02 FIELD PANELS

- A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:
 - 1. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.
 - 2. Field panels located outside fence-secured areas shall be fitted with staple and hasp. Provide padlock and coordinate keying with Owner.
 - 3. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.
 - 4. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sun shield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.
- B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to

the temperature of the lines. Heat tape shall be powered from an equipment-safety GFCI circuit from within panel, unless otherwise shown or specified.

- C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.
- D. Field panels shall be as manufactured by Hoffman, Saginaw Control & Engineering (SCE), or equal.

2.03 CABINET AIR CONDITIONING UNITS

- A. Where indicated or required due to ambient conditions and panel component ratings, panel-mounted closed loop air conditioning units and thermostatically controlled space heaters shall be provided.
- B. Air conditioning units shall both cool and dehumidify the cabinet's internal air. Each air conditioner shall be sized to handle current and future (with specified spare capacity filled) heat loadings from all equipment mounted inside the cabinet.
- C. Air conditioners shall be provided with thermostats which operate the centrifugal evaporator blowers continuously to prevent stratification of air within the cabinet. Compressors shall operate as needed to maintain the temperature set at the thermostat. Compressors shall be provided with space heaters to maintain the compressor at a minimum temperature during cold ambient temperatures.
- D. Ambient air shall be completely separated from the air inside the cabinet. All air conditioner components exposed to the atmosphere outside the cabinets shall be coated to prevent corrosion.
- E. Power supply shall be 115VAC, 60 Hz. Units shall be provided with EMI/RFI noise suppressors.
- F. Air conditioner enclosures shall be constructed of stainless steel or cold rolled steel which is phosphatized and finished in baked enamel.
- G. Cabinet air conditioners shall be ProAir CR Series as manufactured by McLean Midwest of Brooklyn Park, MN, or equal.

2.04 TERMINAL BLOCKS

- A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.

- B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.
- C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

2.05 NAMEPLATES

- A. Items of equipment installed in control panels 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 – EXECUTION

3.01 FABRICATION

- A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.
- B. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

- C. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:
1. For NEMA 12 cabinets only, louvered openings near the bottom and top or thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet. Air velocities through the enclosure shall be minimized to assure quiet operation.
 2. Thermostatically controlled, low noise internal air blowers to circulate air within the enclosure, maintaining a uniform internal temperature. Initial setpoint shall be 75 degrees F.
 3. All intake openings in cabinets and panels shall be fitted with dust filters.
- D. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.
- E. The temperature inside each enclosure containing digital hardware (e.g., PLC, computer, Ethernet switch) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure "high interior temperature" alarm shall be displayed on the HMI or OIT.
- F. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened. If panel contains a service light, alarm switch shall also be wired to turn light on when door is opened.
- G. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.
- H. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.
- I. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal

wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.

- J. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring when operating at differing voltages.
- K. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.
- L. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.
- M. A copper ground bus shall be installed in each cabinet and shall be connected to the building power ground.
- N. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 26 05 19 – Low-Voltage Conductors and Cables. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 26 05 19 – Low-Voltage Conductors and Cables. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
- O. Wires shall be color coded as follows:
 - 1. Equipment Ground – GREEN
 - 2. 120 VAC Power – BLACK
 - 3. 120 VAC Power Neutral – WHITE
 - 4. 120 VAC Control (Internally Powered) – RED
 - 5. 120 VAC Control (Externally Powered) – YELLOW
 - 6. 24 VAC Control – ORANGE
 - 7. DC Power (+) – RED
 - 8. DC Power (-) – BLACK
 - 9. DC Control – BLUE

10. Analog Signal – BLACK/WHITE or BLACK/RED

- P. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a circuit will trip only its immediate breaker and not the upstream breaker.
- Q. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.
- R. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power." Letters in the word "WARNING" shall be 0.75 inch high, white.
- S. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING/FINISHING

- A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 09 for additional requirements.
- B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.
- C. Panels fabricated from stainless steel shall not be painted.
- D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be otherwise painted.

3.03 INSTALLATION

- A. Refer to Section 40 61 13 – Process Control System General Provisions for additional requirements.

END OF SECTION

SECTION 40 67 63
UNINTERRUPTIBLE POWER SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. One UPS shall be provided for each operator workstation and its peripherals (i.e. printer, network equipment, radio, etc.) provided under this Contract.
- C. One UPS shall be provided for each programmable logic controller (PLC) panel and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC and RTU cabinets shall not be powered by the UPS.
- D. UPS units shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:
 - 1. UPS units for operator's consoles shall be mounted within the consoles.
 - 2. UPS units for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.
- E. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 40 67 00 – Control System Equipment Panels and Racks and its subordinate Sections.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 63 43 – Programmable Logic Controllers

1.03 SUBMITTALS

- A. Sizing calculations, in Watts (W) or Volt-Amps (VA), for all UPS units.
- B. Heat dissipation calculations for all enclosures that contain a UPS unit.
- C. Run time calculation.

PART 2 – EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS

- A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.
- B. UPS units shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
- C. An automatic bypass switch shall be provided with UPS units of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
- D. A manually operated maintenance bypass switch shall be provided for each UPS installation, other than for computers, to allow the hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the load.
- E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC.
- F. Each UPS shall meet the following requirements:
 - 1. Input voltage shall be 117 VAC, single phase, 60 Hz.
 - 2. Voltage regulation shall be +/-5 percent for line and load changes.
 - 3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
 - 4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.
 - 5. The UPS capacity shall be sized for 150% of the connected load.

6. A status monitoring and control panel shall be provided and shall include the following:
 - a. Status indicating lights for both normal and abnormal conditions.
 - b. Individual alarm contacts that shall close upon:
 - 1) Loss of the AC line
 - 2) Low battery level
 - 3) Fault condition.
 - c. Contacts shall be wired to the closest discrete input subsystem. Alternatively, an RS-232 or USB port shall provide UPS status to an operator workstation. All required interface software and hardware shall be provided.
 - d. Circuit breaker for the AC input.
 7. Sound absorbing enclosure.
 8. EMI/RF noise filtering.
 9. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
- G. UPS systems shall be the 9PX series by Eaton, Smart-UPS On-line series by APC/Schneider-Electric, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Where the UPS is mounted within the PLC cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.
- B. Refer to Section 40 61 13 – Process Control System General Provisions for additional requirements.

END OF SECTION

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SECTION 40 68 00.13
PROCESS CONTROL SOFTWARE (MODIFY EXISTING)

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install, and place in satisfactory operation all control and information system software with all required programming and software 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 61 93 – Control System Input/Output List
- C. Section 40 61 96 – Process Control Descriptions

PART 2 – PRODUCTS - (NOT USED)

PART 3 – EXECUTION

3.01 OVERALL SYSTEM CONFIGURATION

- A. The Owner's existing Human-Machine Interface (HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract. The existing software is by Data Flow Systems (DFS) HT3 version 3.2.1.
- B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

3.02 SOFTWARE MODIFICATIONS

- A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel," in the opinion of the Engineer, of the existing SCADA System. Specified features and functions of this Contract that do not already exist, even if only for "look and feel," shall be provided. Details on how to best implement these features and functions shall be discussed with Owner and Engineer.
- B. Major HMI software scope of work shall include, but shall not be limited to, the following:

1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.
 2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.
 3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.
 4. Modify existing reports to include the additional monitoring points specified under this Contract.
 5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.
 6. Update the system status display to include new hardware provided under this Contract.
- C. Ladder logic resident in existing PLCs shall be modified to perform the functions described as specified herein and in Section 40 61 96 – Process Control Descriptions. Specifically, the existing PLCs shall be programmed to accept the I/O specified in Section 40 61 93 – Control System Input/Output List and to make this data readily available on the plant network and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.
- D. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

END OF SECTION

SECTION 40 70 00
INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The instrumentation subcontractor shall furnish, install, test and place in operation instruments as scheduled together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Contractor may elect to install sensors on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as indicated.
- B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Instrumentation Subcontractor shall supervise installation of equipment provided where installation is by other Subcontractors or Contractors.
- C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 67 00 – Control System Equipment Panels and Racks
- C. Section 40 79 00 – Miscellaneous Instruments, Valves, and Fittings
- D. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. Items as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.
- B. Equipment installed in a hazardous area shall meet or exceed Class, Group, and Division requirements as shown on the Drawings, to comply with the National Electrical Code.
- C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:
 - 1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.
 - 2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 40 67 00 – Control System Equipment Panels and Racks, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.
- D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.
- E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Paragraph 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0 to 100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.
- F. Unless otherwise specified, field instrument and power supply enclosures shall be Type 316 stainless steel, fiberglass (or similar, per Engineer's judgement) or PVC coated copper-free cast aluminum NEMA 4X construction.
- G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

- H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for long term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.
- I. All devices furnished hereunder shall be heavy duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.
- J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- K. All analog transmitter and controller outputs shall be isolated, 4 to 20 milliamps into a load of 0 to 750 ohms, unless specifically noted otherwise. All switches shall have double pole, double throw contacts rated at a minimum of 600 VA, unless specified otherwise.
- L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.02 ANALYTICAL INSTRUMENTATION

- A. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.
- B. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.
- C. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.
- D. Each analyzer requiring reagents or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.

- E. Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.
- F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

PART 3 – EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole and shall supervise the installation of process instrumentation supplied under this Division.
2. Work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, the latest version of the American Petroleum Institute (API) Recommended Practice 551 manual (API RP 551) shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two inch diameter pipe stands welded to a 10 inch square by 1/2 inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2 inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.
2. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B 36.19, with stainless steel blind flange for equipment mounting, unless otherwise indicated.

3. Materials for miscellaneous mounting brackets and supports shall be Type 316 stainless steel construction.
4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 05 of the specifications.
5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

- A. The instrumentation subcontractor shall comply with the requirements of Division 01 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his/her designated representative(s), reserves the right to witness any test, inspection, calibration or start up activity. Acceptance by the Engineer of plans, reports, or documentation relating to testing or commissioning activity shall not relieve the Contractor of his/her responsibility for meeting all specified requirements.
- B. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Instruments which fails to meet Contract requirements, or published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.
- C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description of the installation test(s) to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.
- D. Field instrument calibration shall conform to the following requirements:
 1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate or verify factory calibration of each instrument supplied under this Contract and existing instruments shown to its specified accuracy in accordance with the manufacturer's

specification and instructions for calibration. Calibration and verification shall take place under actual process conditions. Forcing outputs shall not be acceptable.

2. Each instrument shall be calibrated/verified at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).
3. The instrumentation subcontractor shall provide a written calibration/verification sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, brief description of how the calibration process was performed, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made. For electronic or powered instruments, the calibration/verification sheet shall also list all configurable parameters that have been modified from their default factory setting.
4. If doubt exists as to the correct method for calibrating or checking the calibration/verification of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.
5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to adjustments, sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to over-voltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and re-calibrated/verified at no cost to the Owner. Equipment that has been adjusted, modified, or moved or there is evidence of such activity shall be re-calibrated/verified at no cost to the Owner.
6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

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
- B. Section 40 70 00 – Instrumentation for Process Systems

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.
- 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. The remote configuration device shall be as specified under Section 40 70 00 – Instrumentation for Process Systems. 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 8750W with optional high accuracy as manufactured by Rosemount, or equivalent by ABB, Endress + Hauser, Foxboro, Krohne, Siemens, Toshiba 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.
- B. Refer to Section 40 70 00 – Instrumentation for Process Systems.

END OF SECTION

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SECTION 40 72 76.26
LEVEL SWITCHES (FLOATS)

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, 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 70 00 – Instrumentation for Process Systems

PART 2 – PRODUCTS

2.01 LEVEL SWITCHES (FLOATS)

- A. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5-inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three-conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings.
- B. Float switches shall be Model ENM as manufactured by Flygt, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

END OF SECTION

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SECTION 40 73 29.13
SUBMERSIBLE LEVEL (PRESSURE) SENSORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the submersible level (pressure) sensors, 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 70 00 – Instrumentation for Process Systems

PART 2 – PRODUCTS

2.01 SUBMERSIBLE LEVEL (PRESSURE) SENSORS

- A. Submersible level (pressure) sensors shall consist of a pressure-sensing probe assembly with a depth cable molded directly to the probe body. Sensing probe housing shall be fabricated of titanium or 316 stainless steel. The depth support cable shall be polyurethane and shall contain a Kevlar strength member, a vent tube, and conductors for electrical power and signal.
- B. The sensor shall contain an encapsulated pressure sensing element which is electrically and physically isolated from the media via a ceramic or titanium isolation diaphragm. The pressure sensing connection shall be protected from damage by a removable acetal nose cone or equivalent guard.
- C. Each submersible level transducer shall be provided with a NEMA 4X termination/junction box and aneroid bellows to prevent moisture from entering the vent tube.
- D. Sensor specifications shall be as follows:
 - 1. Sensor Rating: NEMA 6 (IP68), loop-powered
 - 2. Output Signal: 4-20 mA, 2-wire design
 - 3. Accuracy: $\pm 0.25\%$, F.S. (full scale)
 - 4. Long Term Stability: $\pm 0.1\%$ F.S./year

5. Zero Offset and Span Setting: $\pm 0.25\%$ F.S., max.
 6. Operating Temperature: -20 to +60 degrees C
 7. Compensated Temperature: -2 to +30 degrees C
 8. Overpressure Limits: At least 2x full scale range
 9. Cable Length: As required
- E. Submersible level (pressure) sensors shall be WaterPilot Model FMX 167 by Endress & Hauser, equivalent by Druck, KPSI or Devar, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

END OF SECTION

SECTION 40 75 43.16
LUMINESCENT DISSOLVED OXYGEN ANALYZERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, test, install and place in satisfactory operation the dissolved oxygen (D.O.) analyzers 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 70 00 – Instrumentation for Process Systems

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. One complete spare sensor of each type used shall be provided.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Dissolved oxygen sensors shall be of the luminescent type.
- B. Guard mounting hardware for the D.O. sensors, analyzers, and cleaning systems shall be furnished by the manufacturer for each sensor location, as shown on the Drawings. Mounting hardware for the D.O. sensors shall be installed by the Contractor in accordance with the manufacturer's requirements and recommendations. D.O. analyzer mounting hardware shall be the manufacturer's standard mounting hardware, shall allow the probe to be removed from the process without tools so that it may be cleaned, and shall secure and cushion the probe's signal cable to ensure it does not get damaged as the probe moves in the process tank. Mounting hardware shall submerge the sensor head 12 to 24 inches below the water surface.

2.02 LUMINESCENT DISSOLVED OXYGEN SENSORS

- A. Luminescent-type sensors shall be based on luminescent technology where blue light from an LED is directed onto a luminescent coating on the sensor cap, and the coating then emits red light that is detected by the sensor. The oxygen concentration is then correlated directly from the time of decay of the red light generated by the luminescent coating material. A red LED shall be used as an internal reference standard to maintain accuracy.

- B. Probes shall be factory calibrated; initial field calibration shall not be required. Calibration shall be performed via single-point procedure in 100% water saturated air.
- C. Probes shall have an integral temperature sensor with its data made available to the controller.
- D. The sensor shall be submersible and shall consist of a stainless steel probe body with a replaceable sensor head assembly coated with luminescent material. The sensor shall have an integral sensor cable with a quick disconnect plug for connection to the analyzer. It shall be the Contractor's responsibility to determine and provide the proper length of cable between the transmitter and the sensor.
- E. Sensor specifications shall be as follows:
 - 1. D.O. accuracy: +/-0.05 mg/L < 1 mg/L DO; +/-0.1 mg/L < 5 mg/L DO; +/-0.2 mg/L > 5 mg/L DO
 - 2. Temperature accuracy: +/-0.2°C
 - 3. Repeatability: ±0.1 mg/L
 - 4. Resolution: 0.01 mg/L DO; 0.1% saturation
 - 5. Measurement Range: 0-20.0 mg/L
 - 6. Response Time: T95 < 60 sec; T90 < 40 sec at 20 degrees C
 - 7. Max. Immersion Depth: 34 m (112 ft) in water
 - 8. Operating Temp. Range: 0 to 50 degrees C
- F. Dissolved oxygen sensors shall be the Hach LDO Model 2, or equal.

2.03 DISSOLVED OXYGEN CONTROLLERS

- A. The microprocessor-based dissolved oxygen controller shall be compatible with the luminescent dissolved oxygen sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.
- B. Controllers shall meet the following minimum functional requirements:
 - 1. Housing: NEMA 4X
 - 2. Power Supply: 115 VAC, 60 Hz
 - 3. Operating Temperature: -20 to +60°C, 0-95% relative humidity, non-condensing

- C. The controller shall have three relay contact outputs that can be configured based on the dissolved oxygen level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The analyzer shall have two linear, isolated 4-20mA assignable outputs. Where scheduled or otherwise specified, the controller shall be furnished with Modbus RS232/485, Profibus DP, or HART communication capability.
- D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.
- E. Dissolved oxygen controllers shall be the Hach sc200 Universal Controller, or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

END OF SECTION

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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 61 13 – Control and Information System Scope and General Requirements
- 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. 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. Green: running, on, or opened
 2. Amber: fault, alarm, or warning
 3. White: generic non-alarm status
 4. 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.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 40 67 00 – Control System Equipment Panels and Racks, for additional requirements.

END OF SECTION

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SECTION 40 78 56

ISOLATORS, INTRINSICALLY-SAFE BARRIERS, AND SURGE SUPPRESSORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, and place in satisfactory operation the isolators, intrinsically-safe barriers, and surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Control and Information System Scope and General Requirements
- B. Section 40 67 00 – Control System Equipment Panels and Racks
- C. Section 40 78 00 – Panel Mounted Instruments

1.03 TOOLS, SUPPLIES AND SPARE PARTS

- A. The following specific spare parts items shall be provided:
 - 1. Five of each type of surge protection device provided under this Contract.

PART 2 – PRODUCTS

2.01 SURGE PROTECTION

- A. General
 - 1. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.
 - 2. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Edco, Transtector, Weidmuller, or equal.
 - 3. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.
 - 4. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.

5. Device Locations: As a minimum, provide surge protection devices at the following locations:
 - a. At connections between AC power and electrical/electronic equipment, including, but not limited to, panels, assemblies, and field mounted analog transmitters.
 - b. At both ends of analog signal circuits that have any portion of the circuit extending outside of a building.
 - c. At both ends of copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.
 - d. On all external telephone communication lines.

B. AC power protection

1. Surge protection device assemblies for connections to AC power supply circuits shall:
 - a. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.
 - b. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.
 - c. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events and shall have status indication lights.
 - d. Comply with all requirements of UL 1449, latest edition.
 - e. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
 - f. Have the following characteristics:
 - 1) Maximum Continuous Operating Voltage: 150VAC
 - 2) Maximum Operating Current: 20 amps
 - 3) Ambient Temperature Range: -20 degrees C to +65 degrees C

- 4) Response Time: 5 nanoseconds

C. Analog signal circuit protection

1. Surge protection device assemblies for analog signal circuits shall:
 - a. Have four lead devices with DIN Rail mounting.
 - b. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
 - c. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.
 - d. Comply with all requirements of UL 497B.
 - e. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.
 - f. Limit line-to-line voltage to 40 volts on 24VDC circuits.
 - g. Have the following characteristics:
 - 1) Maximum Continuous Operating Voltage: 28VDC
 - 2) Ambient Temperature Range: -20 degrees C to +65 degrees C
 - 3) Response Time (Line-to-Line): 5 ns

D. Communication circuit protection

1. Surge protection devices for copper-based data communication circuits shall:
 - a. Be designed for the specific data communication media and protocol to be protected (e.g., telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF).
 - b. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:
 - 1) IEC 60-1 / DIN VDE 0432 part 2
 - 2) CCITT K17 / DIN VDE 0845 part 2
 - 3) IEEE C62.31

- c. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.
- d. Provide automatic recovery.

2.02 INTRINSICALLY SAFE BARRIERS AND RELAYS

- A. Intrinsically safe relays and barriers shall be provided where required to interface with equipment located in Classified (i.e., hazardous) areas.
- B. Intrinsically safe relays and barriers shall be FM approved.
- C. Manufacturer shall be
 - 1. Pepperl+Fuchs
 - 2. Crouse Hinds
 - 3. Square D
 - 4. Or equal.

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. See Section 40 78 00 – Panel Instruments and Accessories, for additional requirements.

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 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 40 61 13 – Process Control System General Provisions
- B. Section 40 70 00 – Instrumentation for Process Systems

1.03 SUBMITTALS

- A. Per Section 40 61 15 – Process Control System Submittals
- B. Impulse piping layout and routing drawings
- C. 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).

PART 3 – EXECUTION

3.01 REQUIREMENTS

- A. Refer to Section 40 70 00 – Instrumentation for Process Systems.

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. The 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.

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 and standards. All standards shall be the latest version as of the date of project bidding.
 - 1. Hydraulic Institute
 - 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
 - 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
 - a. ANSI/ASME B73.1 Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process
 3. American Petroleum Institute
 - a. ANSI/API Standard 610 Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
 4. American Water Works Association
 - a. ANSI/AWWA E103 Standard for Horizontal and Vertical Line-Shaft Pumps
 5. American Society for Testing and Materials

- 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
- a. B16.1 Standard for Cast Iron Pipe Flanges and Flanged Fittings
 - b. B16.5 Standard for Pipe Flanges and Flanged Fittings

7. ANSI/NFPA 70 National Electric Code
8. Society of Automotive Engineers SAE J404 Chemical Compositions of SAE Alloy Steels
9. Standard, ISO 1940 – Mechanical Vibration – Balance quality requirements for rotors balance quality grade for rotors in a constant rigid state.

1.03 ACTION/INFORMATIONAL SUBMITTALS

- A. Product Data: Comply with Section 01 33 00 – Submittals.
- 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 pump performance curves at rated speed and reduced speeds (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, and NPSH required. Curves shall identify minimum continuous stable flow (minimum flow to avoid suction recirculation), preferred operating region (POR) and allowable operating region (AOR) per the latest version of ANSI/HI 9.6.3. 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
 - c. NPSH required
 - d. Pump Efficiency
 - e. A minimum of 10 data points shall define the pump performance curves listed above. Performance curve data points shall include the following:
 - 1) best efficiency point
 - 2) all specified operating points

- 3) preferred operating range minimum and maximum
 - 4) allowable operating range minimum and maximum
 - 5) shutoff condition
 - 6) runout.
 - 7) The remainder of the points shall be distributed evenly to clearly define the shape of each of the curves.
 - 8) Each data point shall be reported to a minimum of three (3) significant figures.
 - 9) 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 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. Dimension between bearings
 - g. General dimensions of pump
 - h. Suction head bolt orientation
 - i. Anchor bolt locations
 - j. Forces.
 5. Drive and motor data as required by Division 26 Electrical. 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 bearing types and bearing life.
 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 couplings, shaft guards, v-belt drive systems, etc.
 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. Minimum allowable pump submergence
 - d. 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. Shipment, Delivery, Handling and Storage instructions.

1.04 CLOESOUT SUBMITTALS

- A. Submit warranty documentation in compliance with:
1. Specification Section 01 33 00 – Submittals
 2. 01 61 00 – Product Requirements and Options.
- 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. Comply with Section 01 78 43 – Spare Parts and Extra Materials
- C. Comply with 01 79 00 – Instructions to Owner’s Personnel.
- D. Comply with 46 00 00 – Equipment General.

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. Preliminary field test data.
- F. System field quality control testing
- G. Final field test data.

1.07 GENERAL INFORMATION AND DESCRIPTION

- A. Comply with Specification Section 46 00 00 – Equipment – General Provisions.

1.08 DYNAMIC ANALYSIS

- A. Dynamic analyses shall be performed to determine the potential for a critical natural frequency (lateral, torsional, or structural) occurring within the application’s operating speed range of the pumps. All dynamic analyses shall be performed in accordance with the latest edition of ANSI/HI 9.6.8 – Rotodynamic Pumps Guideline for Dynamics of Pumping Machinery.
 - 1. Types of analyses, level of analysis, and minimum frequency separation margins required for each pump service is indicated in the individual pump specification sections. If no specific dynamic analysis requirements are included in the individual pump specification section, the shop drawing submittal shall include a

statement that no critical speeds fall within a range of 25% below to 25% above the pump operating speed range.

2. The analyses shall identify natural frequencies (critical speeds) of the equipment and demonstrate that these natural frequencies are outside of the pump normal operating speed range and associated excitation frequencies by the specified frequency separation margin. Excitation frequencies to be considered in the analyses shall include 1x running speed, 2x running speed, and vane pass frequency. Torsional analyses shall also consider 1x line frequency, 2x line frequency, and VFD excitations.
 3. Pump operating speed range used in the dynamic analyses shall extend from the minimum to the maximum operating speeds required by the manufacturer to satisfy the full range of the specified pump operating conditions.
- B. Where Level 1 analyses are required in the individual pump specifications, the manufacturer shall perform the following:
1. Lateral analysis shall include standard calculations using established equations to calculate a value for the first transverse (lateral) critical speed of the rotor.
 2. Torsional analysis shall include standard calculations using established equations to calculate a value for the torsional critical speed of the pump/motor rotor system.
 3. Structural analysis for vertically suspended (VS), vertically mounted overhung (OH), and vertically mounted between bearing (BB) type pumps shall include calculation of the structural reed critical frequency (RCF) of the vertical pump/motor structure.
- C. Where Level 2/3 analyses are required in the individual pump specifications, the following analyses shall be performed by a qualified third party such as Mechanical Solutions, Inc of Whippany, NJ or Engineering Dynamics Inc of San Antonio, TX. or by a qualified specialist employed by the manufacturer with demonstrated experience in these types of analyses on at least 20 similar projects.
1. Lateral Analysis for VS Type Pumps: The pump shall be subject to a first dry critical speed analysis. If natural frequencies fall within the specified separation margins, and if reasonable modifications cannot adequately shift the natural frequencies outside of the separation margins, then the pump rotor and the surrounding structure shall also be subject to a lateral forced response analysis, and this shall be performed as a combined structural analysis. The lateral forced response analysis shall demonstrate that the pump will function properly over the entire speed range and shall comply with the vibration acceptance criteria as per ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values. Where required by the individual pump specifications.

2. Lateral Analysis for OH & BB Type Pumps: The pump, motor, and shafting shall be subject to an undamped natural frequency analysis as a minimum. For pumps with hydrodynamic bearings, a damped natural frequency analysis shall be performed. If natural frequencies fall within the specified separation margins, and if reasonable modifications cannot adequately shift the natural frequencies outside of the separation margins, then a forced damped response analysis shall be performed to demonstrate that the pump will function properly across the full operating speed range.
3. Torsional Analysis: An undamped torsional natural frequency analysis shall be performed for the entire motor-coupling-shaft drive train. If natural frequencies fall within the specified separation margins, and if reasonable modifications cannot adequately shift the natural frequencies outside of the separation margins, then a torsional forced damped response analysis shall be performed to demonstrate compliance with the specified vibration acceptance criteria and shall demonstrate that infinite service life shall be achieved.
4. Structural Analysis for horizontally mounted OH and BB type pumps: The pump and supporting structure (baseplate) in combination shall be subject to a shaft-end deflection analysis (static structural finite element analysis, FEA). The pump and supporting structure (baseplate) in combination shall also be subject to a natural frequency analysis (modal FEA). The analysis shall include piping to first pipe support or expansion joint, including water mass. If the pump is located on concrete pedestal or an elevated slab, the analysis shall include the nearby foundation in accordance with ANSI/HI 9.6.8 if indicated in the individual pump specification sections. Any concrete foundation features included in the analysis shall be based on a final design for these items based on the equipment provided. If natural frequencies fall within the specified separation margins, and if reasonable modifications cannot adequately shift the natural frequencies outside of the separation margins, then the pump and supporting structure in combination shall be subject to a forced response analysis. The forced response analysis of the structure shall demonstrate compliance with the vibration acceptance criteria as per ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values.
5. Structural Analysis for VS type pumps and vertically mounted OH and BB type pumps: The combined pump/motor/baseplate structural system (including the pump column and bowl assembly and piping out to the first pipe restraint or expansion joint including water mass), shall be subject to a natural frequency analysis (modal FEA). Analysis shall consider the motor RCF tolerance stated by the motor manufacturer (or at least 10%, unless RCF has been verified by test) when determining compliance with specified separation margin. If required by the individual pump specifications, the analysis shall include concrete supports and adjacent elevated slab, in accordance with ANSI/HI 9.6.8. Any concrete foundation features included in the analysis shall be based on a final design for these items based on the equipment provided. Where required by the individual

pump specifications, the structural analysis shall include the surrounding foundation mass and stiffness as recommended in ANSI/HI 9.6.8. Any concrete foundation features included in the analysis shall be based on a final design for these items based on the equipment provided. If natural frequencies fall within the specified separation margins, and if reasonable modifications cannot adequately shift the natural frequencies outside of the separation margins, then the pump and supporting structure in combination shall be subject to a forced response analysis to demonstrate compliance with the vibration acceptance criteria as per ANSI/HI 9.6.4 Rotodynamic Pumps for Vibration Measurements and Allowable Values.

D. Reporting of Results

1. Prior to manufacture, a submittal shall be provided to the Engineer demonstrating that the required dynamic analyses have been performed and that the specified requirements will be met. Reports shall be in accordance with ANSI/HI 9.6.8. Reports for Level 2 or Level 3 dynamic analyses shall be sealed by a professional engineer. The report shall include the following:
 2. A Level 1 lateral, structural, or torsional dynamic analysis report shall include:
 - a) A statement that the analyses were performed in accordance with the requirements of ANSI/HI 9.6.8.
 - b) Equations used, with references
 - c) Equation input values used
 - d) Results obtained including a statement of the margin of separation from rated speeds.
 3. A level 2 or level 3 lateral, structural, or torsional dynamic analysis report shall include:
 - a) A statement that the analyses were performed in accordance with the requirements of ANSI/HI 9.6.8.
 - b) Computer program used.
 - c) Assumptions made in order to model the system.
 - d) Schematic diagram of the model depicting nodes and elements.
 - e) Input data consisting of node coordinates, element types, material properties, element characteristics, element connectivity presented graphically, and specified displacements.
 - f) Any supporting calculations and data.
 - g) Motor or other drive reed frequency data, or dynamic analysis, if recommended (for structural or lateral analysis).
 - h) Motor or other drive critical speed data, by the manufacturer (for structural or lateral analysis).
 - i) Motor ISO 1940 balance level.
 - j) Shafting critical speed data, by the manufacturer (structural or lateral analysis).
 - k) Pump and drive equipment torsional data by the respective vendors (for torsional analysis)
 - l) Shafting and coupling torsional data by respective vendors (for torsional analysis)

- m) Anticipated excitation frequencies.
- n) Analysis results, including all significant natural frequencies and a description of the corresponding mode shapes.
- o) A Campbell diagram depicting a plot of excitation frequency versus operating speed, with the following information:
 - i. A plot of all excitation sources that are multiples of the operating speed, properly labeled.
 - ii. A plot of natural frequencies versus operating speed.
 - iii. Areas of interference of 1) and 2) described above clearly identified, or the lack of likely resonance indicated
- p) Interpretation of the results and recommendations, including recommendations for appropriate corrective action.

1.09 WARRANTY

- A. Warranty requirements shall be as specified in Section 01 61 00 Product Requirements and Options. 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.

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.

B. Comply with ACI 351.3R-04 – Foundations for Dynamic Equipment.

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	Material
Casings and Bowls	Close-grained gray cast iron, conforming to ASTM A 48, or equal
Impellers	ASTM B 148, aluminum bronze
Shafts	Type 400 series stainless steel
Miscellaneous stainless steel parts	Type 316 series stainless steel
Anchor Bolts and Fasteners	Type 316 stainless steel

2.04 STRUCTURAL STEEL

- A. Structural steel used for fabricating equipment supports, etc. shall conform to the requirements of Section 05 12 00 – Structural Steel.
- B. 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

2.05 DISSIMILAR METALS

A. All dissimilar metals shall be isolated in accordance with 05 10 00 Metal Materials and to the satisfaction of the Engineer.

2.06 GALVANIZING

A. Where required by the equipment specifications, galvanizing shall be performed in accordance with Section 05 05 13 – Galvanizing.

2.07 STANDARDIZATION OF GREASE FITTINGS

- A. Grease Fittings: Comply with 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 be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations.
2. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.
3. Comply with 46 00 00 – Equipment General Provisions protective guard requirements.

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 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 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.
- D. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 26 unless otherwise specified in the pump specification.
- E. Motor starters and controls shall be furnished and installed under Division 26 and Division 40 unless otherwise specified in the individual pump specifications.

2.10 SPARE PARTS AND SPECIAL TOOLS

- A. Accessories, spare parts, and special tools shall be provided in accordance with Section 01 78 43 Spare Parts and Extra Materials.
- B. Spare parts for equipment shall be furnished where indicated in the equipment Specifications and/or where recommended by the equipment manufacturer.
- C. Spare parts shall be identical and interchangeable with original parts.
- D. The Contractor shall furnish a one-year supply of all recommended lubricating oils and greases.

2.11 EQUIPMENT IDENTIFICATION

- A. Comply with the requirements of 46 00 00 – Equipment General Provisions.
- B. All pumps 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. model number
 - 4. serial number
 - 5. and 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 Specification 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. Pump tests shall utilize the actual motors and pumpmotor bases and couplings to be furnished with the pumping equipment. Where required as indicated by the individual pump specification sections, variable speed pumps shall be tested with the actual variable speed controllers supplied for the project. Use of the pump manufacturers standard test motors and test stand is not acceptable.
- D. Factory testing shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests. For submersible pumps, testing shall be conducted in accordance with the latest version of ANSI/HI 11.6.
- 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 Specification Section 46 00 00 – Equipment General Provisions wherever individual pump specifications call for witness testing
 - 3. Pump rating point shall be within the tolerances specified for Acceptance Grade 1U unless otherwise specified in the individual pump specifications.
 - 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 tests shall be conducted to demonstrate compliance with the specified NSPH requirements. Where full curve NPSH testing is required, a minimum of four points shall be tested.
 - 6. Certified test curves shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications.
 - a. (Not used)

- b. Certified curves shall identify minimum continuous stable flow (minimum flow to avoid suction recirculation) and preferred operating region (POR) and allowable operating region (AOR) per the latest version of ANSI/HI 9.6.3.
- 7. Where required by the individual pump specification sections, factory vibration testing shall be performed to demonstrate compliance with HI 9.6.4.
- 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 or 11.6 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. 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 Brinnell 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. 46 00 00 – Equipment General Provisions
 - 2. Section 26 05 60 – Low-Voltage Electric Motors
 - 3. Section 26 05 61 – Medium Voltage Electric Motors
 - 4. Section 26 05 00 – Basic Electrical Requirements.

3.02 SHIPMENT, DELIVERY, HANDLING AND STORAGE

- A. Shipment, delivery and handling of equipment and materials shall be in accordance with Section 01 65 00 Product Delivery Requirements.
- B. Storage of equipment shall be in accordance with 01 66 00 Product Storage and Protection Requirements.

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

3. Section 01 79 00 – Instruction of Owner Personnel

- 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	2
Startup and Training	1	2
Services after Startup	1	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, 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 non-shrink grout in accordance with Section 03 60 00 Grout. 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.

3.05 ALIGNMENT

- A. Pumping equipment shall be aligned in accordance with Section 46 00 00 Equipment General, 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. Where specified in the individual pump specifications, the natural frequencies of each installed pump shall be determined using the “bump test” method. Natural frequency testing shall demonstrate a minimum of 10% separation from the 1x running speed, 2x running speed and vane pass frequencies.
 - 4. Pump performance shall be documented by obtaining concurrent readings, showing motor voltage, amperage, pump suction head, and pump discharge head, for at least four (4) pumping conditions at each pump speed. 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.
- 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 46 00 00 – Equipment General Provisions.

3.08 PAINTING

- A. Comply with 46 00 00 – Equipment General Provisions.
- B. Comply with 09 90 00 - Painting.

END OF SECTION

SECTION 43 25 15
SUBMERSIBLE CENTRIFUGAL CHOPPER PUMPS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install submersible recirculator chopper pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.
- B. Equipment shall be provided in accordance with the requirements of Section 46 00 00 – Equipment General Provisions and Section 43 20 00 – Pumps, General.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. The chopper pumps shall be specifically designed to pump waste solids at heavy consistencies without plugging or dewatering of the solids. Materials shall be chopped/macerated and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood paper products and stringy materials without plugging, both in tests and field applications.

Secondary Scum Pumps

Number of Units	3 ⁽¹⁾		
Design Capacity (gpm)	170	220	285
Total Dynamic Head (feet)	35	31	25
Minimum Efficiency at Primary Design Point	40%		
Maximum Brake Horsepower	5 hp		
Approximate Pump Speed (rpm)	1750		
Temperature of Liquid Pumped	Ambient		
Suction Condition	Flooded		
Minimum Discharge Diameter (In.)	3		
Recirculation Assembly?	Yes		

(1) One pump shall be a complete, uninstalled spare unit.

1.03 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. Shop Drawings
 - 2. O&M Manuals
 - 3. Performance Affidavit

1.04 WARRANTY AND GUARANTEE

- A. Warranty and Guarantee shall be as specified in Section 46 00 00 – Equipment General Provisions.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Submersible centrifugal chopper pumps shall be Model S3M (Curve C) by Vaughan, Model CHOPX3-A by Hayward Gordon, “or equal”.
- B. Other manufacturers may be evaluated for acceptance as “or-equal” in accordance with Instructions to Bidders; Article 11.

2.02 MATERIALS

- A. Pumps with fabricated impeller, cutter bar or casing shall not be acceptable. Add-on cutting mechanisms below the pump inlet shall not be acceptable.
- B. Casing
 - 1. The pump casing shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb. flanged centerline discharge.
 - 2. Casing shall be ASTM A536 ductile cast iron or ASTM A48 Class 30 cast iron with all water passages smooth, and free of blowholes and imperfections for good flow characteristics.
- C. Impeller
 - 1. Shall be semi-open type with pump out vanes to reduce seal area pressure. Partial back shroud vanes shall also be acceptable.

2. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of .010" to .015".
3. Impeller shall be ASTM A148 alloy steel, case hardened to minimum Rockwell C 60 and dynamically balanced.
4. The impeller shall be keyed or threaded to the shaft and shall require no axial adjustments and no set screws.

D. Cutter bar

1. Shall be recessed into the pump bowl, and shall extend diametrically across entire pump suction opening.
2. Cutter bar shall be plate steel hardened to minimum Rockwell C 60.

E. Cutter Nut

1. The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding at the pump inlet.
2. The cutter nut shall be cast steel hardened to minimum Rockwell C 60.

F. Upper Cutter

1. Shall be a replaceable item, designed to reduce and remove stringy materials from the mechanical seal area. Alternatively, the area behind the impeller shall be protected from fouling by the cutting and expulsion action of serrated and sharpened teeth in the rear impeller shroud sweeping across spiral grooves in the backplate.
2. Upper cutter shall be cast steel hardened to minimum Rockwell C 60.
3. The set clearance between the impeller and upper cutter shall be adjustable to .010" or less

G. Pump Shafting: The pump shaft and impeller shall be supported by ball bearings. Shafting shall be AISI 4140 heat-treated steel, or equal with a minimum diameter of 1.5 inches.

H. Bearing Housing

1. Shall be A536 ductile cast iron or equal, and machined with piloted bearing fits for concentricity of all components.
2. If applicable, the bearing housing shall have oil bath lubrication using ISO Gr. 46 turbine oil.

3. Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. Overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 1.2". A third mechanical seal shall be provided to isolate the bearings from the pumped media at operating temperatures to 250 F. The third seal, as well as the thrust bearings shall be oil bath lubricated in the bearing housing, if applicable. Bearings shall be rated with a minimum B10 bearing life of 100,000 hours.
- I. Pump Mechanical Seal: Shall be fitted with silicon carbide seal faces and shall ride on a Type 316 stainless steel shaft sleeve. Seal shall be tested for flatness within 2 Helium light bands under a Helium light source and optical flat.
 - J. Shaft Coupling
 1. Submersible motor shall be close coupled directly to the pump, using a solid sleeve coupling keyed to the pump and motor shafts.
 2. Slip clutches and shear pins between the shaft and motor shall not be accepted.
 - K. Recirculation Assembly
 1. The pump shall be fitted with a recirculation nozzle assembly to permit recirculation of the pit contents prior to discharge. The recirculation nozzle shall be adjustable minimum 180 degrees horizontally and 45 degrees vertically.
 2. A valve assembly shall be connected to the pump discharge to adjust pump flow either to the nozzle or the pump discharge flange. Valve shall be ASTM A536 ductile cast iron or ASTM A48 class 30 cast iron, with Type 316 stainless steel valve disk and 150 lb. flanged recirculation and discharge flange.
 3. The diverter valve and recirculation nozzle shall each be controlled by operating levers which shall extend up through a mounting plate for easy access during pump operation.
 - L. Automatic Oil Level Monitor: If applicable, a clear PVC oil reservoir with float switch shall be mounted at the top of the wet well, with a hose feeding down to the side of the bearing housing to detect oil level and shut off the motor in event of low oil level. A sensitive relay shall be included for mounting in the motor control panel.
 - M. Gauges and name plates shall be furnished per Section 43 20 00 – Pumps, General.
 - N. The guide rail system shall consist of two stainless steel guide rails, cast ductile iron pump guide bracket and discharge elbow with mounting feet and 125 lb. flanges, an upper guide rail mounting bracket and intermediate guide brackets every 10 feet.
 - O. The Slide Rail Mounting System shall be as shown on the Contract Drawings and as specified herein.

1. A rail system shall be provided and installed for each pump. The pump shall be easily removed from the wetpit for inspection or service without entering the pit or disconnecting piping.
2. The pump shall be provided with a foot mounted discharge connection elbow constructed of cast iron conforming to ASTM A48-Class 30 or 35, permanently installed in the wet well along with the discharge piping. The discharge connection elbow shall be constructed with a 125 lb. ANSI standard flat faced flange. The pump shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple downward motion of the pump.
3. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by the guide bar(s) and pressed tightly against the discharge connection elbow to provide positive sealing under all conditions.
4. The entire sliding rail system shall be designed to safely withstand all stresses imposed thereon by vibration, torque, shock and all possible direct and eccentric loads. No portion of the pump shall bear directly on the floor of the sump.
5. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be of at least standard weight 316 stainless steel pipe of a conservative size adequate for its intended use. The guide bars shall not support any portion of the weight of the pump.
6. All anchor bolts, lifting bolts, eye lugs and lifting cable, etc. necessary for a complete installation and maintenance of the pump shall be constructed of Type 316 stainless steel and shall be adequately designed for its intended use.
7. All metal to metal interfaces where movement might occur shall be non-sparking. The slide mounting system for the influent pumps shall meet or exceed Underwriters Laboratory requirements for operation in a Class I, Division 1, Group D hazardous location.

- P. All anchor bolts, lifting bolts, eye lugs, etc. necessary for complete installation and maintenance of the pump shall be furnished by Supplier and constructed of Type 316 stainless steel and shall be adequately designed for its intended use.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

- A. All switches, conduits, enclosures, boxes, and other electrical appurtenances furnished by the equipment manufacturer shall be as specified in Division 16 and shall be rated as indicated on the Drawings. Each switch and protective device furnished by the equipment manufacturer shall be furnished with an equipment-mounted junction box for connection of field wiring. All electric controls, relays, and accessories shall be as specified in Section 26 09 16 – Electric Controls and Relays.

B. The pump manufacturer shall provide the power and control cables between the pump and the local disconnect switch, junction box, or control panel (see Drawings) and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same pumping application shall be provided with the same length of cable. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant chloroprene rubber jacketed type SPC cable suitable for submersible pump applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.

C. Electrical Requirements

Motors	Secondary Scum Pumps
Rating	460V, 3 ph, 60 Hz
Horsepower	5 hp
Speed, rpm	1700
Insulation	Class F
Explosion Proof	Yes
Inverter Duty	No
Service Factor	1.15
Motor Winding Temperature Switches	Yes
Motor Space Heater	Yes
Moisture Sensor	Yes
Cooling Jacket	No

D. The pump motor shall be a squirrel-cage induction type, housed in a watertight chamber. The stator winding and stator leads shall be moisture resistant. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.

E. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of ten (10) starts per hour without overheating.

F. The motor shall be provided with pre-lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.

G. All motors shall be of nationally known manufacture, shall be housed in enclosures specifically designed for submersible pump application.

- H. Moisture detector probes shall be provided in the oil-seal chamber. The pump manufacturer shall provide a moisture detection relay compatible with the probes.
- I. Lower bearing temperature sensors (if required in schedule) shall be provided to contact the outer race of the thrust bearing providing for accurate temperature monitoring.
- J. The pump manufacturer shall provide a pump protection relay which shall monitor moisture detection and high temperature. The relay shall be handed over to the electrician for integration into the pump's MCC bucket.
- K. Cable Entry Water Seal
 - 1. The cable entry water seal design shall insure a watertight and submersible seal without specific torque requirements. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate gaining access through the pump top. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal O-ring. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to the terminal board and thus perfectly leak proof. Each pump shall be equipped with separate terminal board that totally isolates the incoming power supply from the pump motor.
 - 2. An acceptable alternate cable entry seal shall include cable leads shall enter at the top of the motor and shall allow the cable-to-motor connection to be accomplished in the field without soldering. All power and control lead wires shall be double sealed as they enter the motor in such a manner that cable-wicking will not occur. This sealing system shall consist of a rubber grommet followed by epoxy that is high in adhesive qualities and has a low coefficient of expansion. Each conductor shall have a small section of insulation removed to establish a window area of bare wire and each wire shall be untwisted and surrounded by epoxy potting material. A cable strain relief mechanism shall be an integral part of the sealing system. The cable sealing system shall be capable of withstanding an external pressure test of 1,200 psi as well as a cable assembly pull test as required by Underwriters Laboratories. Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be O-ring sealed.
- L. Motor shall be rated for 15 minutes of in-air operation and shall have tandem mechanical seals in oil bath and dual moisture sensing probes. Motor shall include two normally closed automatic resetting thermostats connected in series and imbedded in adjoining phases. Motor frame shall be cast iron, and all hardware and shaft shall be stainless steel.

- M. If applicable, an automatic oil level switch shall be provided to stop the pump in the event of low oil level.

2.04 SPARE PARTS

- A. Spare parts shall be provided in accordance with Section 46 00 00 – Equipment General Provisions.

1	Set of lower and upper wearing rings
1	Set of motor and pump bearings
1	Complete mechanical seal assembly (upper and lower)
2	Complete set of gaskets and O-ring seals
1	Complete pump assembly (uninstalled)

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. For each series of pumps, field services shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1
Services after Startup	1	1

3.02 SHOP TESTING

- A. Shop testing shall be in accordance with Section 46 00 00 – Equipment General Provisions and Section 43 20 00 – Pumps General.

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 herein, 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 with 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.

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.

1.03 ACTION/INFORMATIONAL SUBMITTALS

- A. Product Data: Comply with Section 01 33 00 – Submittals Procedures
- B. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with 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.
 - 3. Detailed equipment dimensional drawings and setting plans.

4. Drive and motor data as required by Division 26 – Electrical. 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.
5. Information on bearing types and bearing life.
6. Gear box design and performance criteria and AGMA service factor.
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. Any additional information required to demonstrate conformance with the equipment specifications.
12. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.
13. Shipment, delivery, handling, and storage instructions.

1.04 CLOSOUT SUBMITTALS

- A. Submit warranty documentation in compliance with:
 1. Section 01 33 00 – Submittal Procedures
 2. Section 01 61 00 – Product Requirements and Options
- 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. Spare Parts and Extra Materials:

1. For spare parts, extra stock materials, and tools, submit quantity of items specified in associated Specification Section.
2. Submit complete list of spare parts, extra stock materials, maintenance supplies and special tools required for maintenance for one year with unit prices and source of supply. Indicate number/quantity specified and furnished, manufacturer, part number, description, etc.

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. Preliminary field test data
- F. Final field test data

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.

1.08 EQUIPMENT WARRANTIES

- A. Warranty requirements shall be as specified in Section 01 61 00 – Product Requirements and Options and Section 01 75 00 – Checkout and Startup Procedures. Warranty requirements are supplementary to the individual equipment specifications.

PART 2 – PRODUCTS

2.01 ANCHORS AND SUPPORTS

- A. 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 suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.
- B. Anchor bolts and fasteners shall be furnished in accordance with Section 05 05 23 – Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, guard bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.
- C. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 6” high, unless otherwise shown on the Drawings and shall be doweled.
- D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. 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 non-shrink grout, unless alternate methods are recommended by the manufacturer and

are acceptable to the Engineer (such as shim leveling pumps, or chemical grout). Non-shrink grout shall be as specified in Section 03 60 00 – Grout.

2.02 STRUCTURAL STEEL

- A. Structural steel used for fabricating equipment shall conform to the requirements of Section 05 12 00 – Structural Steel.
- B. 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.

2.03 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.

2.04 GALVANIZING

- A. Where required by the equipment specifications, galvanizing shall be performed in accordance with Section 05 05 13 – Galvanizing.

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 pump 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.

- 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 (NOT USED)

2.08 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 the manufacturer's name, year of manufacture, serial number, and principal rating data.
- B. Each pump and other 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". 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 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. (Not used)
- E. Shop 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.

3.02 SHIPMENT, DELIVERY, HANDLING AND STORAGE

- A. Storage of equipment Shipment, delivery and handling of equipment and materials shall be in accordance with Section 01 65 00 – Product Delivery Requirements.
- B. and materials shall be in accordance with Section 01 66 00 – Product Storage and Protection Requirements.

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 his 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. Training: Training shall be provided in accordance with Section 01 79 00 – Instruction of Owner Personnel.
 5. 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 his 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 the Engineer's field representative one week prior to installation.

- B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.
- C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.
- D. All equipment sections and loose items shall be match-marked prior to shipping.
- E. 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.
- 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.

3.05 ALIGNMENT

- A. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to +/- 1/16 inch unless otherwise noted on the drawings. Wedges shall not be used for leveling, aligning, or supporting equipment.
- B. General Equipment Leveling: Non-rotating equipment shall be set level to +/- 1/16 inch per 10-foot length (.005 inch per foot) unless otherwise noted on the drawings. Shims shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment baseplate 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.
- C. Grouting
 - 1. Fill anchor bolt holes or sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.
 - 2. Surface Preparation. Roughen surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale. Saturate area with water at least 4 hours prior to grouting, removing excess water ponds.
 - 3. Application. Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions. Eliminate all air or water pockets beneath the base using a drag chain or rope.

4. Finishing. Point the edges of the grout to form a smooth 45-degree slope.
 5. After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.
 6. Level Verification. After grout has cured, and immediately prior to drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.
- D. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.
- E. Inspect and clean equipment mounting base pads, feet, and frames to remove all grease, rust, paint, and dirt.
- F. Assembled equipment shafts shall be set level to .0015 inches per foot of shaft length (+/- .0005 inches) up to a maximum of 0.015 inches for any length shaft unless the manufacturers requirements are more stringent or unless otherwise noted in the equipment specifications. 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.
- G. Sprocket and Sheave Alignment. 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.
- H. Belt tensioning. Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.
- I. 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.
- J. Rotating Shaft Alignment
1. Fixtures will be set up on the driver and driven machine, machines shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.
 2. Primary alignment method for direct drive machines is when coupled. Uncoupled alignment will be used only when approved by the Engineer.
 3. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.

4. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.
5. Indicator bar sag will be measured and included for each reverse indicator alignment setup.
6. Reverse Dial Indicator. The final maximum allowable misalignment: vertical and horizontal from the desired targets of .000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions simultaneously: 1/2 the final total indicator reading at each indicator will be no more than shown in the table below AND the final remaining correction at each machine foot be no more than .001 inches of required movement.

Machine Speed (RPM)	Total Misalignment* (inches)
Up to 1800	.002
1800 and greater	.001

* 1/2 indicator reading

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 manufacturer's 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 his 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 his assigned representative and the Owner or his 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 as specified herein.
 - b. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded.
 - c. Recheck alignment with dial indicators 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 his 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 his 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 PAINTING

- A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable paragraphs of Section 09 90 00 – Painting.
- B. All shop coatings shall be compatible with proposed field coatings.
- C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high-quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.
- D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.10 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

SECTION 46 51 19
ROTARY DISC SURFACE AERATORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, adjust, and place in satisfactory operation all Disc Aerators as shown on the Drawings and specified herein.
- B. Equipment shall be provided in accordance with the requirements of Section 46 00 00 – Equipment General Provisions.
- C. The Rotary Disc Aerators shall generally consist of aeration disc assemblies, shaft assemblies, shaft-mounted drive assemblies, bearings with bearing base plates, splash shields, and all accessories and appurtenances as specified herein and as indicated on the Contract Drawings.
- D. The Manufacturer and Contractor shall thoroughly review the conditions of service and mounting arrangements for the proposed aerators including basin geometry, flow path, freeboard, baseplate/anchorage, and support and shall select equipment suitable for the proposed application.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. The Disc Aerators shall be located in the Oxidation Tanks as indicated on the Drawings and as specified herein. The Aerators shall be capable of delivering adequate aeration to the Oxidation Tanks as well as providing thorough mixing to maintain solids in suspension.

B. Aerator Schedule

Oxidation Tank Aerators

General Requirements

Type	Rotary Disc
Number of Units	6
Number of Discs per Unit	23
Disc Diameter ⁽¹⁾	66"
Maximum Brake Horsepower per Unit	40 bHP
Maximum Aerator Speed	52.0 rpm

Aerator Performance

Alpha Factor	0.95
Beta Factor	0.95
Design D.O. Concentration	2.0 mg/L
Design Standard Oxygen Requirement (SOR) ^{(2) (3)}	415 lb O ₂ / hr
Standard Oxygen Transfer Efficiency (SOTE)	2.7 lbs O ₂ / HP-hr

Aerator / Tank Dimensions

Disc Spacing	9"
Channel Width at Aerators	20'-0"
Distance between Support Bearings	21'-0"
Mounting Arrangement	Baseplate
Baseplate Elevation (bottom of baseplate)	639.05
Shaft CL Elevation	639.71
Design Disc Immersion	21"
Maximum Disc Immersion	24"
Minimum Water Surface Elevation (21" Disc Immersion)	638.71
Maximum Water Surface Elevation (24" Disc Immersion)	638.96

⁽¹⁾ 54" discs shall not be considered as an alternate.

⁽²⁾ This value reflects the minimum design SOR for both Oxidation Tanks (all six aerators combined).

⁽³⁾ The aerators shall be able to deliver a combined SOR = 654 lb O₂/hr.

1.03 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. Shop Drawings
 - 2. O&M Manuals
 - 3. Calculations for gear reducer AGMA service factor. Calculations shall be sealed by a Professional Engineer.

1.04 WARRANTY AND GUARANTEE

- A. Warranty and Guarantee shall be as specified in Section 46 00 00 – Equipment General Provisions with the exception that the warranty period shall be for five (5) years.

PART 2 – MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. The Rotary Disc Aerators shall be provided by Evoqua Water Technologies LLC of Waukesha, Wisconsin, “or equal”.
- B. Other manufacturers may be evaluated for acceptance as “or-equal” in accordance with Instructions to Bidders; Article 11.

2.02 CONSTRUCTION

- A. Disc Aeration Equipment
 - 1. Total of six (6) complete disc rotary aerator assemblies as shown on the Drawings.
 - 2. There shall be provided a total of one-hundred-thirty-eight (138) circular aeration discs, located as determined by the Manufacturer in order to provide the required volume of oxygen.
 - 3. The discs shall be manufactured in the USA. Discs shall be fabricated of 1/2" thick molded polystyrene structural foam, resistant to corrosive action of the mixed liquor being aerated. Each disc shall have a compound for ultra-violet stabilization. A multiplicity of cavities and raised protrusions shall be provided across the face of each disc to cause entrained air to be dispersed in the mixed liquor. The raised protrusions shall be of cup shape with a trailing tail.
 - 4. The aeration discs shall be firmly attached to the shafting by means of a shaft locating collar. This shaft locating collar shall be an integral part of the aeration

discs. To enable the individual discs to be attached, adjusted, or removed from the shafting without disassembling the shafting, discs shall be split into half sections held in position by bolts at the shaft. All bolts, washers and nuts shall be 304 stainless steel.

5. The disc manufacturer/seller shall submit a certificate verifying manufacture location of the discs and ownership of the disc molds. If validation of ownership is not of the manufacturer/seller this shall be grounds for rejection.
6. Contractor shall be required to field install discs, and set disc location along the shaft as required meeting the specifications and the treatment process as determined by the Manufacturer and the Engineer.

B. Aerator Shafting

1. Aerator shafts shall be made from solid, 6" diameter, SAE 1045 machine steel bar stock, turned and polished. Shaft ends shall be true concentric.
2. The shafting shall be capable of withstanding all dead, live, and radial loads imposed on it. Maximum allowable deflection shall be 0.15 inch per 10 ft. length of shaft.
3. Shafts to be blast cleaned per SSPC-SP10-63. Shafts shall be coated in accordance with Section 09 90 00 – Painting, with coatings applied to ensure proper fit-up between the aeration discs.

C. Bearings

1. Each aerator shaft shall be supported by self-aligning, grease lubricated, roller bearings with cast iron pillow block housings. Housings shall be coated for corrosion protection according to this proposal. Each of the bearings shall have double row spherical roller bearings with locking collars to secure the bearing to the shaft. Heavy duty contact seals shall be provided to insure positive sealing against contaminants. The seals shall be designed for operation in a moisture laden environment.
2. Minimum B-10 bearing life shall be 200,000 hours.

D. Bearing Base Plates

1. Base plates shall be provided for setting the pillow block bearings. Base plates must be set and grouted level by the contractor in accordance with approved general arrangement drawings. Bearing base plates shall be fabricated from commercial quality steel and coated for corrosion protection according to the specification specified herein. Stainless steel hardware shall be provided for securing the bearings to the base plates.

E. Remote Bearing and Automatic Lubrication System

1. A remote lubrication system will be provided for each bearing assembly. The system will provide convenient access for bearing lubrication by the plant operator.
2. The remote lubrication system will consist of tubing and an installation kit. Fit-up and installation is to be by the contractor.
3. A Memolub or equal automatic lubricator shall be installed which will deliver small, metered amount of grease over a period of time.
4. The system shall be factory pre-lubricated with Mobil 460.
5. System Schedule

Specification	
Operation:	Electro-Mechanical, PD-type pump
Lubricant cartridge capacity:	240cc, 1 pt or 480cc , 2 pt (Replaceable)
Connection thread:	1/4" NPT Male
Max operating pressure:	350psi (25 bar)
Temperature Range:	5°F to 120°F (-15°C to 50°C)
Output timing settings:	52 Adjustable settings
Power supply:	4.5VDC Alkaline battery pack
External On/Off Control	No
Remote Installation:	Up to 40 feet, single point*
Reusable:	Yes
Multi-Point:	2pt for double bearing; 1pt for single bearing

F. Splash Shields

1. Splash shields shall be provided to prevent the wetting of bearings, and drive units from disc spray. Shields shall be constructed of galvanized steel.
2. Mounting brackets for the splash shields shall be fabricated from commercial quality steel and hot dip galvanized for corrosion protection. Components for the splash shields shall be shipped loose for field assembly and installation by the contractor in accordance with Manufacturer’s instructions, and approved general arrangement drawings.
3. Neoprene seals shall be attached to the splash shields where the shaft passes through the plate.

G. Rotor Immersion Gauge

1. One (1) rotor immersion gauge shall be provided for each channel to indicate disc submergence levels. Gauge shall be anodized aluminum.

H. Flow Control Baffle

1. Flow control baffles shall be provided for installation as shown on the drawings.
2. The baffles shall be constructed of hot-dipped galvanized steel and mounted to the wall near each shaft bearing location.

I. Anchors and Hardware

1. All anchor bolts shall be 304 stainless steel and furnished by the Manufacturer and set with proper projection by the Contractor in accordance with approved, certified drawings furnished by the Manufacturer.
2. All hardware shall be 304 stainless steel.

J. Painting

1. Equipment components shall be coated in accordance with Section 09 90 00 – Painting

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

- A. All electrical appurtenances furnished by the equipment manufacturer shall be rated for installation in a Class I, Division 2, Group D, hazardous location.
- B. The drive mechanism for each aerator assembly shall consist of a single speed motor and a shaft mounted AGMA Class II helical gear reducer sized for 24-hour continuous operation with allowance for moderate shock loads. The motor and reducer shall be fully suitable for outdoor service and exposure to the atmosphere encountered and shall be coated for corrosion protection according to the manufacturer's standards.
- C. An adjustable torque arm shall be provided to secure the reducer in position. The reducer shall be attached to the motor using a cast iron adapter.

D. Electrical Requirements

Motors	Disc Aerators
Rating	460V, 3 ph, 60 Hz
Horsepower	40
Speed, rpm	1800 ⁽¹⁾
Enclosure	TEFC
Insulation	Class H
Explosion Proof	Yes
Inverter Duty	Yes
Service Factor	1.00
Space Heater	Yes
Motor Winding Temperature Switches	Yes

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 for each unit or set of units (based on installation and startup schedule):

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

- B. During startup, the Manufacturer is responsible for providing input on the adjustable weir settings to coordinate the water level in the Oxidation Tanks with the Disc Aerators.

3.02 (NOT USED)

3.03 FIELD TESTING

- A. Field Testing shall be in accordance with Section 46 00 00 – Equipment General Provisions.

- B. The Contractor shall make modifications that may be required to provide vibration within specified tolerances in accordance with the Manufacturer's and/or Engineer's recommendations without additional cost to the Owner.

END OF SECTION